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New England Water Works Association

ISSUED QUARTERLY

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THE Association was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 800 men. Its membership is divided into six classes, viz.:

A Member shall be an officer or employee of a public or private water works, an engineer, chemist or other person qualified to aid or interested in the advancement of knowledge relative to water works.

An Honorary Member shall be a person of acknowledged eminence in some branch of water supply or of engineering.

A Junior shall be not less than eighteen years nor more than twenty-five years of age, a student or connected with water supply work.

An Associate shall be either a person, firm or corporation engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works.

A Corporate Member shall be either a Water Board, Commission, Company or Municipal Corporation.

The initiation fees and annual dues are as follows:

	Initiation Fees	*Annual Dues*
Members	$ 3.00	$ 6.00
Juniors	1.00	3.00
Associates	10.00	20.00
Corporate Members	10.00	10.00

This Association has at least eight regular meetings each year, of which five are held in Boston, one in northern New England, one in southern New England, and one, the annual convention, held in September on such date as the Executive Committee may designate.

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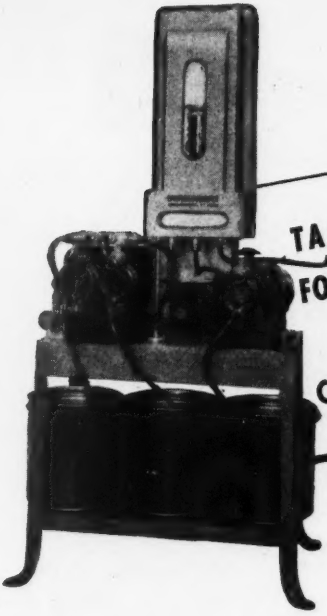

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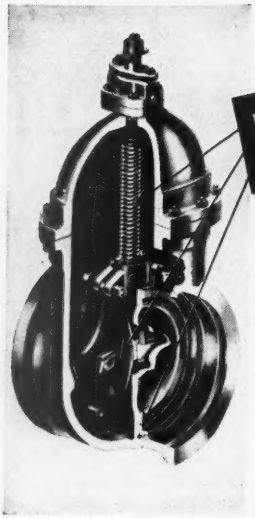

1. Continued turning of valve stem.
2. Brings wedges into action and expands the discs against their seats.
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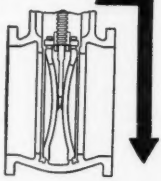
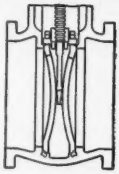
DO NOT WEDGE PREMATURELY

All the Way DOWN



and then OUT



Because of its unique side wedging action, the discs of a Smith Gate Valve are not expanded laterally until after they have completed their travel and fully cover the ports. Termination of the discs' travel and further turning of the valve stem actuates the wedges and expands the discs. In opening, the action is reversed, the wedges are fully released before the discs commence to travel to an open position.

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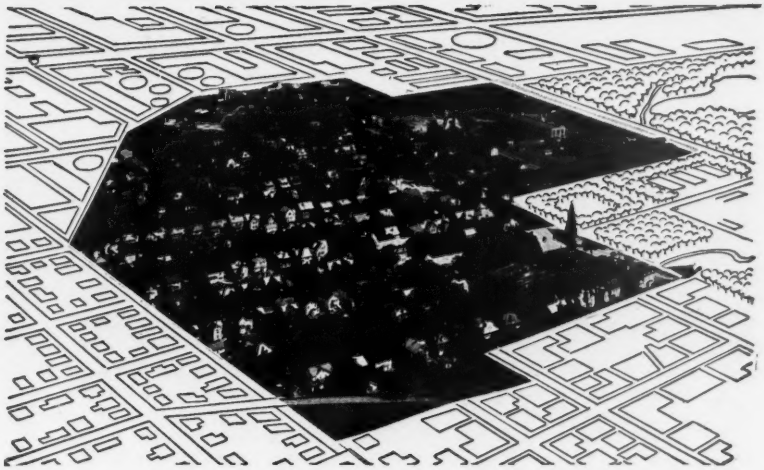

Will the water pipe you install today meet *TOMORROW'S* needs?

IF you are planning a water system to meet the needs of tomorrow, it will pay you to give careful consideration to the pipe you install today. For not only the initial cost of the system, but even more important, *its operating economy in the long run,* may be at stake!

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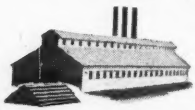

Modern equipment for the proper application of primers and enamels over mechanically cleaned pipe is available at numerous application contractors' plants, which apply Barrett protective coating systems while the pipe is in transit to your destinations.

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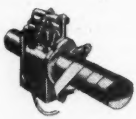

Thousands upon thousands of miles of pipelines have been protected with Barrett primers, enamels and asbestos felts, application being made over the ditch with modern traveling coating equipment and with increasing efficiency and low costs.

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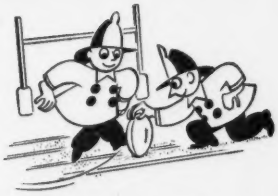

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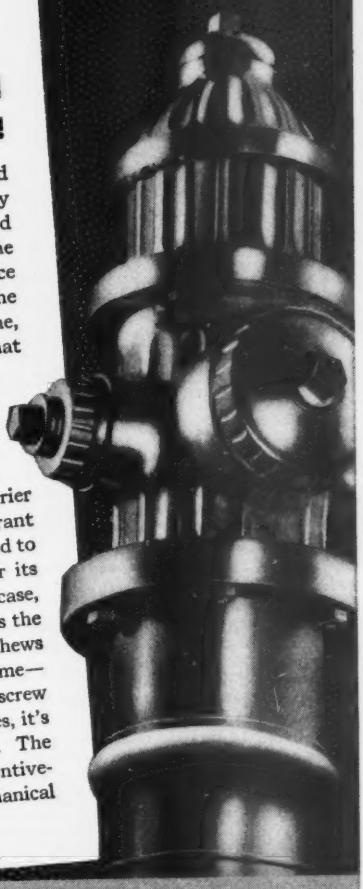
Fire and water departments the world over have a warm feeling for any Mathews Hydrant, and with good reason—it doesn't run out on the team. Weather makes no difference to it—it works in summer, when the going's easy; and it works the same, sure way in winter—which is what fire-fighters like about it, and have liked about it for generations.

All working parts are enclosed in a *removable* barrel, so designed as to be a perfect barrier against rain, snow, and hydrant water. A Mathews is not subjected to strain as the ground freezes, for its tough "Sand-Spun" protection case, free to move up and down, takes the thrust. If ever damaged, a Mathews can be back in service in no time—it's a matter of minutes to unscrew the barrel and replace it; besides, it's all an *above-pavement* job. The Mathews is a marvel of inventiveness; in fact, it is a mechanical triumph.



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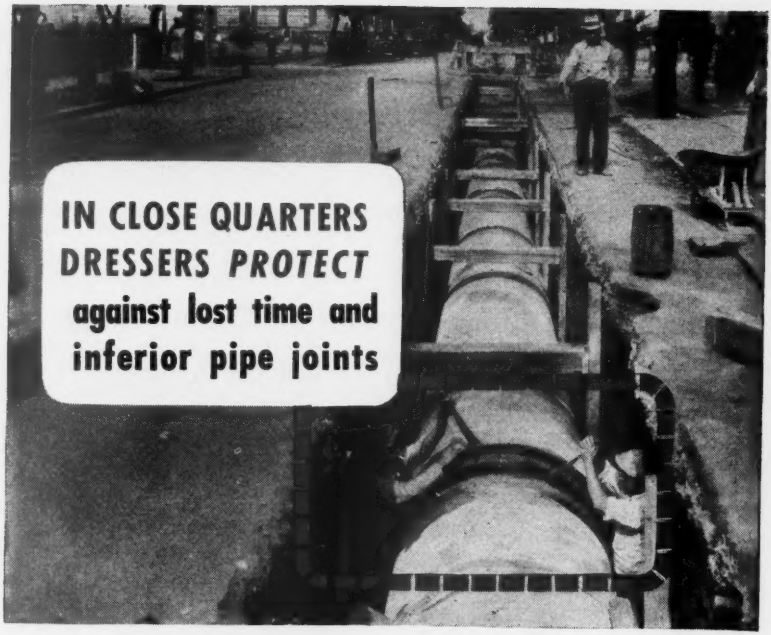

In metropolitan areas, narrow ditches and cramped working spaces, due to traffic congestion and subsurface structures, often impede the rapid installation of pipe lines. This means loss of time and money.

The use of Dresser Couplings speeds installation in city streets and, at the same time, assures a *uniform, permanently tight pipe joint.* Dressers' simplicity and ease of assembly allow any workman to join pipe quickly and efficiently under the most difficult conditions.

Avoid prolonged traffic tie-ups, expensive machinery breakdowns and delays due to inclement weather. Choose the coupling which can be assembled any time, anywhere, with uniform performance assured under all conditions.

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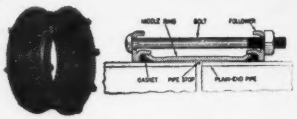

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Very few parts . . . all factory built . . . easy to assemble. Style 38 Couplings are made for pipe from $\frac{3}{8}$" to 60" and larger.

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New England Water Works Association

ORGANIZED 1882

VOL. LX DECEMBER, 1946 No. 4

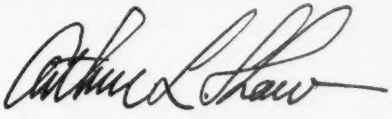
This Association, as a body, is not responsible for the statements or opinions of any of its members

A MESSAGE

THE last issue of each volume of the JOURNAL of the New England Water Works Association is the first issue published following the accession of a new administration. Its appearance near the close of an old year and the start of a new one makes appropriate both a forward and a backward look.

The years which lie immediately ahead will not be easy times for the water-supply industry. Plant and equipment, worn out and overloaded during the war years, must be made to serve through the present period of reconversion and readjustment, until materials become more freely available through the relaxation of government controls and the gradual satisfying of pent-up demands. Labor will continue to be scarce and independent until relative responsibilities come to be viewed in proper perspective by both employers and employees. Nevertheless, it is to be expected that the trend will be one of general and steady improvement and it is inconceivable that the water-works people who carried on so splendidly during the trying years of war can be anything but successful during ensuing tribulations.

In retrospect, the members of this Association inherit an honorable tradition of nearly 65 years of development and growth, since the founding of the Association in 1882. This tradition and the sustaining influence of mutual friendship and respect among the members will be an inspiration to all in smoothing the pathway to solution of present and future problems, and in continuing the cooperative fellowship which should make the New Year a significant and pleasant one.



President

ADDITIONS TO SPRINGFIELD'S TRANSMISSION MAINS

BY PETER C. KARALEKAS*

[*Read September 17, 1946.*]

THE Springfield water-supply system has been described before this organization several times in past meetings, I believe. Nevertheless, I should like, at this time, to present a brief description of our reservoir system and treatment works.

BRIEF DESCRIPTION OF SYSTEM

The city of Springfield and surrounding towns are provided with water from the so-called Little River Supply, located some fifteen miles west of the city. There is also available for use the Ludlow Reservoir Supply, which serves several small towns, as well as one large industry in the city, and is located about twelve miles east of the city.

The original modern supply for the city came from the Ludlow Reservoir. These works were established in the year 1875 and continued in use until 1910, when Borden Brook Reservoir, a part of the present Little River Supply, was constructed.

The Ludlow Reservoir has a capacity of 1.855 billion gallons at elevation 373 ft and a drainage area above the dam of 20.5 sq mi. The total safe yield of this system is about 11 mgd.

Water is delivered to four intermittent, open, slow sand filters, each with a capacity of 3 mgd, by means of a steam-driven centrifugal-pump installation. Two open-storage distribution reservoirs have a combined capacity of 34.2 mil gal.

The transmission mains from the Ludlow system consist of a 24-inch cement-lined wrought-iron pipe, constructed in 1874, and a 36-inch and 30-inch cast-iron main, laid in 1894. These lines are connected to the Little River Supply main at the Indian Orchard section of the city. At present, Ludlow Reservoir supplies the town of Wilbraham, the Monsanto Chemical Co. and, when required, part of the demand of the city of Chicopee.

*Chief Water Engineer, Municipal Water Works, City Hall, Springfield, Mass.

At the time of the construction of Borden Brook Reservoir, there was also constructed a small intake reservoir, having a storage capacity of some 40 mil gal. This intake reservoir is located about one mile west of the site where the slow sand filtration plant was built. The filtration plant consists of 3.0 acres, built in 1909, and 3.2 acres, built in 1925. Water from this intake reservoir is diverted to the filtration plant through a tunnel 5,356 ft long, having a capacity of 100 mgd.

When Cobble Mountain Reservoir was completed in 1932, it became a functional part of the water-supply system, along with this intake reservoir and filtration plant. Cobble Mountain dam is a hydraulic-fill structure, rising 243 ft above the old river bed, and has a bottom width of 1,510 ft, a top width of 50 ft and a length across the stream at top of 730 ft. The reservoir has a storage capacity of 22.829 billion gallons and a surface area of 1,134 acres at a flow-line elevation of 952 ft above mean sea level. The system as a whole has a total storage capacity of 25.3 billion gallons, a safe yield of 55 mgd and a total watershed area of 48.5 sq mi.

One interesting feature of this source of supply is the facilities provided for the generation of electric power, under controlled conditions. With 456 ft of available head between the flow line of Cobble Mountain Reservoir and the intake reservoir, a hydro-electric plant was constructed above this intake reservoir, so that now all water used for water-supply purposes passes through the turbines of this electric generating plant. The water is delivered to this power plant through a pressure tunnel about 8,000 ft in length, having a capacity of 600 mgd.

Before the water enters the filters, it is impounded in a sedimentation basin having a capacity of 43 mil gal and an area of 10 acres. When necessary, a coagulant is added to the water before entering this basin.

Filtered water flows to the covered distribution reservoir at Provin Mountain through seven miles of 42-inch, lock-bar, riveted steel pipe, laid in 1909, as well as some 13,000 ft of 51- and 59-inch all-welded steel pipe, laid in 1943. These two lines are interconnected and have a combined capacity of 30 mgd when the water elevation at Provin Mountain is at 400 ft above mean sea level.

The so-called Provin Mountain distribution reservoir is located some five miles west of the city and has a flow-line elevation of 404.75 ft. It consists of two covered concrete chambers, built in two sections, having a combined storage capacity of about 29 mil gal.

Water flows to the city from this reservoir through both a north and a south line. The north line, built in 1909, is a 42-inch, lock-bar, riveted steel line, extending some five miles to the west bank of the Connecticut River. The river crossing is made up of two 30-inch steel lines. The south line, on the other hand, is some seven miles in length and was laid in 1928. It is composed of 3⅛ miles of 54-inch and 3⅛ miles of 48-inch electrically welded steel pipe, with riveted girth joints. The river crossing on the south side of the city is a dual 36-inch steel line.

Present Carrying Capacities of Transmission Mains

For protection against corrosion and to maintain carrying capacity, these steel lines were all coated by being dipped into a coal-tar preparation before being laid in the ground. In 1945, the last of a number of flow tests was completed on the 42-inch line between the filters and Provin Mountain. Based on these results, there are shown in Table 1 the estimated present carrying capacities of our transmission mains, as determined by the Hazen and Williams formula:

Table 1.—Estimated Carrying Capacities of Springfield's Transmission Mains

Section	Size (inches)	Length (feet)	Date of construction	Initial capacity [C=140] (mgd)	FLOW TEST Capacity (mgd)	H & W "C"	Estimated capacity 1946 (mgd)
Filters to Provin Mtn.	42	39,000	1909	32.0	1930—28.6 1938—27.0 1942—25.8 1945—24.5	125 118 113 108	24.0
Filters to first cross connection	51 and 58	13,000	1943	——	——	——	6.0
Provin Mtn. to city:							
North line	42	24,100	1909	46.5	——	——	35.0
South line	54 and 48	33,000	1928	62.5	——	——	53.0

These results indicate that the Hazen and William flow coefficient has decreased about one unit per year and that in 1942 the single 42-inch transmission main from the filters had a capacity of some 25.8 mgd.

From Table 2 it can be seen that the average daily consumption for Springfield and surrounding towns increased rapidly. With this increase and the rapid growth of activities in industry, due to the expanding war program, it became imperative that a second transmission main from the filters to Provin Mountain Reservoir be constructed.

This need for more carrying capacity was further substantiated by the summer demand of 1941. During the period from June 25 to July 2 of that year, the average flow was 22.7 mgd. On June 27 of this period, the total consumption amounted to 25.28 mgd, with a peak rate of 32.0 mgd. This condition necessitated drawing for four days from the 29-mil gal reserve in the distribution reservoir.

TABLE 2.—AVERAGE DAILY CONSUMPTION FROM LITTLE RIVER SUPPLY

Year	Average daily consumption (mgd)	Year	Average daily consumption (mgd)	Year	Average daily consumption (mgd)
1910	10.4	1923	13.9	1936	16.0
1911	10.5	1924	14.4	1937	15.8
1912	10.7	1925	14.5	1938	15.5
1913	10.8	1926	14.4	1939	16.4
1914	10.9	1927	14.5	1940	16.5
1915	10.4	1928	15.0	1941	18.7
1916	11.4	1929	16.2	1942	18.9
1917	12.1	1930	16.2	1943	21.0
1918	13.4	1931	15.2	1944	21.9
1919	12.3	1932	14.1	1945	22.2
1920	13.0	1933	14.1	1946	22.4*
1921	12.8	1934	14.9		
1922	12.7	1935	14.9		

*Through Aug., 1946.

1942 Construction of Auxiliary Transmission Main

Plans were completed in 1942 to install 52-inch steel pipe from the filters to Provin Mountain over the entire length of 39,000 ft. War restrictions ruled out the use of steel for this particular job. The answer was steel pipe, refabricated out of 26- and 30-inch sizes, purchased from unused yard stocks scattered over various states from Pennsylvania to Texas.

The Federal Works Agency then approved this project and granted $214,800 of funds, made available for this type of work through the Lanham Act. The project at that time was estimated to cost $537,000 for 13,000 ft of 51⅜- and 58⅞-inch pipe. The final cost was $621,365.99. This pipe, delivered on the job, cost $26.27 per foot, as compared with a much lower estimated-cost figure for 52-inch steel, which was to be used originally.

The refabrication of the 26- and 30-inch pipe was done under contract by the Walsh Holyoke Boiler Works in Holyoke, Mass. At this plant, the 26-inch outside diameter, ¼-inch thick pipes and the 30-inch O.D., ⅜-inch thick pipes were split by burning, an automatic gas cutting machine being used along the longitudinal welded seams. The cut sections of pipe were then unrolled by an ingenious method, developed by the Walsh men. In short, this unrolling method consisted of a straightening machine, made up of an arched ⅜-inch steel plate, over which the cut pipe was pulled by six pulling cables leading to a common block. A derrick exerted pull on this block and unrolled one half-section of pipe. To unroll the other half, the pipe was naturally reversed. Walsh Holyoke Boiler Works spent considerable time building this apparatus. The radius of four feet for the arched steel plate was determined after several trials with various dimensions. The straightening machine is illustrated in Figure 1.

The plates were then re-rolled and welded to the new diameter by joining two plates from the 26-inch pipe for the 51⅜-inch inside-diameter size and two plates from the 30-inch pipe for the 58⅞-inch O.D. tube.

The pipe was fabricated in lengths of 30 ft, except for those sections having angle bends, and these were made to length as determined by the plans. Half-circle butt straps were then welded on the ends of each length of pipe.

FIG. 1.—"STRAIGHTENING MACHINE" DEVELOPED FOR THE PURPOSE OF UNROLLING 26- AND 30-INCH PIPE FOR REFABRICATION.

All sections of pipe were coated at the fabrication plant by immersing the cold pipe in a dipping tank containing a coal-tar preparation. This dipping tank is 40 ft deep and has an inner tank, 7 ft in diameter, in which the coal tar and pipe were placed. The coal tar was heated electrically and the temperature maintained by temperature-control apparatus. After the 30-ft lengths of pipe were immersed in this dipping tank, they were allowed to stand for about 30 min, the time depending on the season of the year—a longer period in the colder months. The final step was whitewashing the pipe for protection against temperature changes. It was then ready for shipment to the job site.

The laying of the pipe was awarded to the successful bidding contractor on the basis of cost plus a fixed fee of 6% of the estimated construction cost. The bid for construction costs was $150,000 plus $9,000 for the fixed-fee price. The field construction consisted of the laying, welding together and field pressure-testing of this steel pipe-line. Work was started on January 7, 1943, and the job was finally completed on December 12, 1943.

Minimum cover of four feet was specified and, in the process of excavation, about 3,500 cu yd of ledge rock had to be blasted or broken with paving breakers. There was one large stream crossing at Munn Brook, where a cofferdam of sheet piling was constructed, to facilitate laying and encasing the pipe with concrete.

Pipe was delivered to the job by truck trailer and unloaded on the site by a movable crane, equipped with a padded sling. A tractor was utilized to move the pipe to the trench side on a sled, made out of two wooden piles with padded cradle cross-pieces.

Sections of pipe were placed in the trench by a movable crane, laid to grade and welded directly in the trench. In many cases the pipe delivered on the job was out of round and much care and skill were needed to fit the two pipe lengths together before welding. Pipe sections that were out of round were fitted to the adjoining pipe length by the use of hydraulic jacks, either on the inside or from the trench side of the pipe. The pipe sections were first tack-welded at the joints, welded on the inside by one machine and then on the outside by a second welding machine.

During an unusually heavy rainfall a large section of pipe and

trench was flooded, so that it became necessary to cut into a section of 52-inch pipe to remove the silt that washed inside. The cut is shown in Figure 2.

FIG. 2.—CUT IN STEEL PIPE, MADE TO REMOVE DIRT AND SILT, WASHED INTO PIPE BY A CLOUDBURST.

Because the fabricated pipe could not be tested at the Walsh plant, it was necessary to test the completed line in sections of 1,500 to 2,500 ft. These completed sections were tested only for the line pressure available in the adjoining 42-inch line.

At road crossings the pipe was encased in concrete and provisions were made for future connections by providing flanged sections of six-inch pipe.

In connection with the laying of this section of pipe, a 60" x 22" Venturi tube was installed and the connection made so that all water passed through this meter. There were also constructed two cross-connections to the existing 42-inch line. One of these was located near the filter end of the line, below the Venturi, and the second at the end of this construction, about 13,000 feet to the east. These cross-connections were a 42-inch pipe at the Venturi meter and a 42-inch and 26-inch pipe at the second connection.

Valves used on the job ranged from 8- to 42-inch. One air-vent tower, two air-and-vacuum valve assemblies and chambers, and three 8-inch blow-offs were constructed.

The section of pipe was finally chlorinated before being placed in service, by using a portable Wallace & Tiernan gas chlorinator.

The additional 13,000 feet of welded steel pipe, laid under difficult conditions of both labor and material, increased the carrying capacity of the existing 42-inch main by more than 25%.

Present Construction of Auxiliary Main

Soon after the completion of this section of the 52- and 59-inch installation, it became evident that the 30-mgd capacity available would not be sufficient to meet the increasing demands on the system.

In the summer of 1944, during the period from August 13 to August 20, the average daily consumption was 26.64 mgd. The maximum day's consumption in this period was 30.19 mgd, with a peak rate of 44.0 mgd. Because of the lack of rain at that time, there was a heavy draft, which taxed the reserve and dropped the distribution reservoir to a very dangerous, as well as an uncomfortably low, level.

Again the need for extending this steel auxiliary main was brought out most emphatically during June and July of this year.

During the period from June 26 to July 3, 1946, the average daily consumption was 23.20 mgd. The maximum daily use came on June 27, when the 24-hour consumption went to 29.56 mil gal, with a peak rate of 42.0 mgd.

After pulling through this period of heavy demand, we faced a second and more severe one from July 17 to July 24. The average daily use for this period rose to 24.0 mgd and the maximum day's use to a record-breaking high of 32.02 mgd. The peak rate during this day jumped to 46.7 mgd. This heavy demand was depleting our reserve at the Provin Mountain Reservoir about 1.5 mgd. Then, however, the rains came and another trying situation is now history.

With the coming of VJ Day, plans and specifications were prepared by Malcolm Pirnie, Consulting Engineer, of New York, N. Y., for the completion of the remaining 26,000 ft of this second transmission main.

The plans, as approved by the Board of Water Commissioners of the city of Springfield, called for 25,900 ft of 48-inch welded steel pipe, joined together with Dresser couplings. The pipe will be coated, inside and out, with a coal-tar enamel, using the trough or other approved method of application. This new main is parallel to, and about 25 ft north of, the existing 42-inch steel main on land and easements owned by the city. The first section, as a wartime precaution, was located 40 ft north of the existing line. There was also included appurtenant work, such as gate valves, blow-offs, air and vacuum valves, manholes, masonry chambers and drains, as well as stream, highway and railroad crossings and connections to existing mains.

Sealed proposals or bids for the construction of this section of transmission main and appurtenances were received by the Board of Water Commissioners on May 29, 1946. The proposal contained 25 units of work for which unit prices were proposed. The successful bidder was Demos Bros. General Contractors, Inc., of Springfield, Mass., who submitted a bid totaling $849,052.00 to complete the work. It is hoped that, before snow falls, one-half of the proposed 26,000 ft will be completed, tied into the existing main and put to good use.

The contract for fabricating the pipe was awarded by the contractor to the Walsh Holyoke Boiler Works, who will deliver the pipe

to the job site, as directed in the specifications, ready for installation, for $21.85 per foot. This price includes the couplings, coating and all specials stipulated in the plans. The coating will be applied to the pipe lengths by the Wailes Dove-Hermiston Corp., of New Jersey. The pipe will be fabricated in 34-foot sections and will have not more than two welded longitudinal seams.

The Water Works is planning to retain inspection service, to carry out rolling-mill inspection of steel plates as well as inspection of pipe at the fabrication and coating plants.

Since the start of construction little work has been done, because of the delay in obtaining steel plate, but pipe deliveries are expected to start in early October.

In laying this pipe it will be necessary to cross one small and two rather large streams and to cross under a single-track railroad with sections of 72-inch reinforced-concrete pipe, in which the steel pipe will be laid. Total excavation, estimated at about 55,000 cu yd, includes clearing and backfilling.

Concrete for pipe cover and anchorages will amount to about 800 cu yd. The cross-connection between this line and the old 42-inch will have cast-iron specials, as well as one 30-inch and two 24-inch valves. The line will also be provided with six 6-inch, as well as six 8-inch, air-and-vacuum valve assemblies for protection. Inlet manholes to the pipe are placed approximately every 1,000 ft. Provisions have been made for placing flanged-tee assemblies at road crossings, for future use by the neighboring cities and towns.

With the completion of this line, the carrying capacity of the transmission mains from the filters to Provin Mountain Reservoir will be increased from 30 mgd to 75 mgd, which should care adequately for the needs of Springfield and surrounding cities and towns for many years to come. This capacity will be further increased after the 42-inch line is taken out of service and reconditioned.

Discussion

David E. Moulton (Portland, Me.). How about expansion joints?

Peter C. Karalekas. We take care of that by anchorages. In

the new section, of course, the couplings would take care of any expansion.

RICHARD HAZEN (New York, N. Y.). It might be of a little interest to you to know, in connection with this line, that the old 42-inch line, which was laid in 1908 or 1909, had a coating which, so far as I am aware—I may be wrong—was one of the few dip coatings where linseed oil was used. I think one member described the old lining as 0.02, and the average thickness of the lining was somewhat under 0.02 of an inch, which is quite a lot thinner, of course, than the thickness provided under the present A.W.W.A. enamel lining, which will run 3/32. The line has stood up well; the carrying capacity has dropped from around 130 to 108 in something less than forty years. That apparently has done very well.

In connection with this pipe line, I would say that both steel pipe and concrete pipe were considered and the engineers themselves favored using the concrete pipe.

HAROLD W. GRISWOLD (Hartford, Conn.). Would it have been a cheaper proposition, instead of taking a small-size pipe and cutting it up—making big ones out of little ones—to lay two lines of pipe that you could have obtained by fabricating?

PETER C. KARALEKAS. As I have said, this work was all done before I went to work for the city. I think at that time they probably considered that proposition. But it was a question of getting more water in there quickly. They had a deadline to meet, as far as war contracts were concerned. They were threatened with being taken off the War Industries list of good cities.

PROBLEMS IN DISPOSAL OF SLUDGE AND WASH WATER FOR CONNECTICUT WATER FILTRATION PLANTS

BY FREDERICK O. A. ALMQUIST*

[*Read September 17, 1946.*]

THE disposal of wash water and sludge from rapid sand filtration plants in Connecticut has tended to become more of a problem from the nuisance standpoint. In most cases, water filtration plants are located adjacent to impounded reservoirs, where the stream flow below the dam is lessened because of the reservoir storage of the normal stream run-off. While the discharge of wash water may not be too objectionable, the discharge of sludge while cleaning the coagulation and sedimentation basins, with its high biochemical oxygen demand, frequently results in nuisance conditions. It is the feeling of the writer that, in the past, at the time of the construction of the plant, this problem has not been given as much consideration as other features, which may perhaps be more pertinent so far as the actual successful operation of the plant itself is concerned. After the plant has been placed in operation, the local water utility may be confronted with the problem of the unsatisfactory waste-water disposal. In some cases the solution may be difficult.

There appears to be very little information in the literature with regard to the disposal of filtration-plant waste water. Perhaps in most sections of the country there is sufficient stream flow to furnish enough dilution so that putrescible materials may be oxidized before causing objectionable conditions. In order to provoke thought on this subject, the writer will present some figures on sludge analysis, review the problems encountered at several of the Connecticut water filtration plants and offer some comments on the disposal of the sludge.

SLUDGE ANALYSIS

Samples of sludge have been collected from 13 filtration plants for analysis. Second samples were collected from several plants, so

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the figures below represent the analyses of 18 samples from the 13 plants. No samples of wash water were collected. The maximum and minimum figures are given, together with average figures of all samples. In some instances there is quite a difference between the maximum and minimum. This may be due in some measure to the method of collection. A wide-mouth bottle was used and an attempt made to collect a sample of the thick sludge, after the sludge in the main portion of the basin, containing less solids, had been drawn off. A thicker sludge was collected at some plants than in others. Differences may also occur, of course, as a result of greater aging of sludge at some plants than at others. The interval between sludge drawings varies considerably with the different plants. "Standard Methods of Water Analysis" was followed in the making of the examinations. The results are given in Table 1.

TABLE 1.—SLUDGE ANALYSES

	Maximum	Minimum	Average
Color	—	—	Brown or black
Odor	—	—	Sewage, hydrogen sulphide, disagreeable, sour, decayed vegetable matter
Moisture (%)	99.95	95.8	98.7
Ash (%)	67	27	46
5-Day Biochemical Oxygen Demand (ppm)	1,100	38	337
Oxygen Consumed (ppm)	13,000	270	4,700
Hydrogen-ion Concentration—pH	6.8	5.4	6.1
Aluminum as Al (%)	48	9.8	25.1
Iron as Fe (%)	12	2.3	3.2
Silica—SiO_2 (%)	18.2	1.4	9.6
Calcium—CaO (%)	1.5	0.2	0.7

The figures in Table 1 indicate a sludge slightly on the acid side and with an ash fairly high in minerals, especially aluminum, as might be expected. The sludge is obviously not fit for use as a fertilizer. The figures for oxygen consumed are high and the biochemical oxygen demand might compare with that of a domestic sewage. The odor is the most disagreeable feature and causes the most complaints from the nuisance standpoint.

The bacteriological results may be somewhat surprising. A standard plate count on agar at 37° C for 24 hours was made and the figures ranged from 1,700 to 2,700,000 per ml. The sample showing the highest count showed no confirmation for organisms of the coliform group.

Single portions were examined for organisms of the coliform group in dilutions to a point where no lactose-fermenting organisms were expected. All portions showing lactose-fermenting organisms were carried through to completion. Of the 17 samples examined, 3 were positive in the 0.1-ml dilution, 2 in the 1.0-ml dilution and 3 in the 10-ml dilution. Nine samples showed complete absence of organisms of the coliform group when carried to the 10-ml dilution. These results would indicate that the sludge would probably be of better quality as to the content of coliform organisms than any stream into which it might be discharged.

Problems of Individual Plants

In discussing briefly the problems at the various plants it was thought best to designate them by letters. All Connecticut plants use alum as the coagulant and average rates of dosage probably range between 0.75 and 1.5 grains per gallon.

Plant A. This is a 5-mgd plant, with an average consumption during the war period of about 4 mgd. The coagulation and sedimentation basin is divided into two basins of 420,000 gal each and, at the design rate, the detention period for the entire basin is about 4 hours. The wash water normally used is 156,000 gal for the four filters, which are washed about once a day. Both the wash water and the sludge from the basins are discharged to an open sedimentation basin or lagoon, which in turn discharges to a relatively small brook. The open sedimentation basin was enlarged from a capacity of 400,000 gal to 700,000 gal after the plant was constructed. This was done because property owners below the plant complained of objectionable odors when the basins were cleaned.

Even with the increased capacity, which would furnish only 20 hours' detention should both halves of the basin be cleaned at once, care must be exercised in the process. Advantage is taken of a high brook flow and the lagoon water is decanted by successive opening

of valves at different elevations to a point where the lagoon is practically empty of liquid, before starting to clean the basins. All the discharge passes through the lagoon and the first relatively clear water is allowed to flush through to the brook. The overflow from the reservoir does not feed the receiving brook, so additional diluting water cannot be obtained from the reservoir. By thus starting with an empty lagoon and choosing a favorable time so far as brook flow is concerned, nuisance conditions are minimized and so far no damage has been claimed against the city by property owners along the brook.

In this case, a lagoon allowing 40 hours' detention for the cleaning of half the sedimentation basin has afforded fairly good results. The lagoon will hold the discharge from the entire basin if necessary, provided the first 140,000 gal are wasted by allowing this amount to flow directly to the brook. The basins are cleaned twice a year. So far as wash water is concerned, the detention period is about 4.5 days. The basin, however, is constantly decanted. The sludge is removed by steam shovel or dragline and emptied on the bank, where, because of considerable distance to the nearest house, no nuisance results.

Plant B. There are two similar, 5-mgd filtration plants for this city. Both are located near small streams, one stream being the overflow from the reservoir. At each plant the sedimentation basins have capacities of 1,100,000 gal and the basins are divided in halves and operated in parallel. The consumption is close to 3 mgd for each plant under normal conditions. Open sedimentation basins or lagoons of an estimated capacity of a little more than 500,000 gal and 450,000 gal, respectively, have been provided. The detention period is therefore close to 24 hours, when the lagoons are free of sludge. The theoretical detention period for wash water is roughly 4 days.

Complaint has been received in the office of the State Department of Health, from a farmer below the first plant, that the cows will not drink the brook water when the basins are being cleaned and that the odor is objectionable. In order to remedy this, a second lagoon is being contemplated, not on the brook but adjacent to it, for the sedimentation-basin sludge, the existing lagoon to be used for wash water only. In the meantime, the sedimentation basins are cleaned once or twice a month during the summer season, with the

thought that odors may be less with shorter periods for possible putrefaction of the sludge.

Objection has been voiced by a property owner below the second plant, who wishes to construct a swimming pool, that the dark water containing activated carbon and the odor prohibit him from constructing the pool. The stream also runs through a golf course, where objectionable conditions are experienced during the playing season. Another lagoon is being contemplated, which should be helpful, and in the meantime the basins are cleaned in the spring and fall of the year to minimize objectionable conditions.

Plant C. This plant is a rapid sand filtration plant, consisting of 12 filters with a total capacity of 8.5 mgd. The sedimentation basin has a total capacity of 1,050,000 gal, divided into three basins of 350,000-gal capacity each which are operated in parallel. The average consumption is about 8.5 mgd. On the basis of the design capacity, the detention period is about 3 hours. Cleaning of the basins is done 3 or 4 times a year.

The receiving stream is small, being the overflow from the reservoir. There are several pools, used for decorative purposes, below the plant on privately owned estates of moderate size, through which the stream flows. In the past a number of complaints have been received from these property owners, because of nuisance conditions, and the water company has been threatened with law suits, especially as a result of the discharge of sedimentation-basin sludge. It has been necessary for the company to employ the services of a mechanically operated shovel to excavate the muck from these pools, in order to maintain the good will of the property owners.

For the purpose of remedying conditions, the water company, after a number of laboratory experiments, constructed two sludge-drying beds. The beds have surface areas of approximately 4,000 sq ft and 13,000 sq ft, respectively, and are constructed as shown in Figure 1. These beds were constructed just before the war, the first one at a cost of $4,500 and the second at $3,950. Because of a more favorable terrain, the cost of the second was less than the first, although the second is more than three times as large in plan area. The beds were similarly constructed, with 4-inch tile underdrains placed at 10-foot centers in gravel trenches 8 in. deep. The trenches

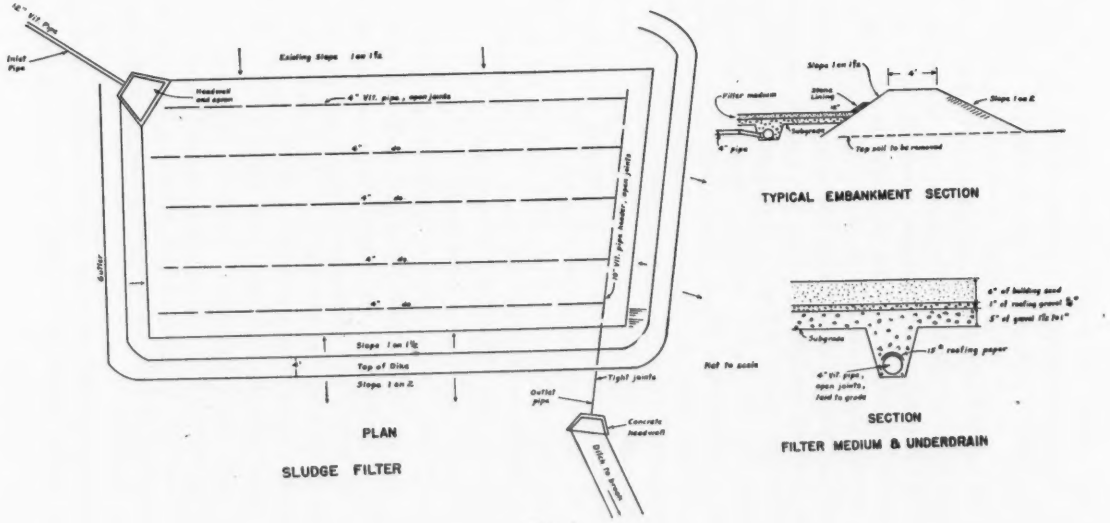

Existing Slope 1 on 1½
Headwall and apron
4" Vit. pipe, open joints
Gutter
Slope 1 on 1½
Top of Dike
Slope 1 on 2
Tight joints
Outlet pipe
Concrete headwall
PLAN
SLUDGE FILTER
Slope 1 on 1½
4'
Filter medium
Slope 1 on 2
4" pipe
Top soil to be removed
TYPICAL EMBANKMENT SECTION
6" of building sand
1" of roofing gravel
5" of gravel
Subgrade
Not to scale
4" tile pipe, open joints, laid to grade
SECTION
FILTER MEDIUM & UNDERDRAIN

FIG. 1

were filled with gravel and over the entire floor area were placed 5 in. of gravel, 1 in. to 1½ in. in size. A second layer of pea gravel, 1 in. in depth, was laid over the first. This gravel supports a 6-inch layer of washed sand.

Although the discharge pipe and valves are at the bottom of the sedimentation basin, when the valve is opened to draw down a basin, a cone is pulled through the sludge and relatively clear water emerges for about one-third the capacity of the basin being emptied. This is by-passed around the sludge bed to the brook. When the discharge becomes turbid, the remaining liquid and sludge are turned on to the sludge beds. The operation is to dose the smaller bed to a depth of 3 ft and the larger one to a depth of somewhat over 1 ft. The plant chemist has found, through a series of experiments, that the sludge dewaters more rapidly and cracks more quickly at a pH value of 5.2 than at the normal value of 6.8. Commercial muriatic acid is added to the sludge as it is drawn, a 12-gal carboy being used for one basin of 350,000-gal capacity.

The sludge becomes fairly dry at the end of 3 weeks and can be handled by shoveling into a wheelbarrow. The moisture content at this time is about 85%. There is some odor in the vicinity of the beds with the sludge on it. The effluent is quite clear, being scarcely noticeable in the brook. The sludge is used for fill and there is very little odor when the sludge is spread as fill.

In spite of the construction of the sludge beds, the water company is now faced with a sludge problem again. Property adjacent to, and only a few feet from, the sludge beds has recently been purchased and the new owner proposes to construct a dwelling house. At this distance the odors would, of course, be objectionable. Whether or not, if the new owner constructs the proposed dwelling, he is in a position to collect damages is not within the province of this paper, but obviously the water company is desirous of remedying the condition without court action. This, together with the fact that some complaints are still being received because of wash-water discharge to the brook, has prompted the water company to try changing the method of sludge disposal.

This company now proposes to pump the sludge and wash water to the upper end of the reservoir and has made application for ap-

proval to the State Department of Health. The lake has a capacity of 550,000,000 gal. The wash water averages about 4% of the water filtered, which amounted to 104,800,000 gal of wash water alone during 1945. The department has the proposal under investigation.

Plant D. The city in which the plant in question is located has a 10-mgd rapid sand filtration plant, including 5 filters. The sedimentation basin is divided into two basins operated in parallel. At design capacity the two basins, with total capacity of 1,685,000 gal, have a detention period of close to 4 hours. These basins are cleaned about three times a year. The rate of wash water is 12,000 gpm.

When construction of the filtration plant was started in 1939, it was recognized that disposal of wash water and the sedimentation-basin sludge might present a problem, since the only stream available is the overflow from the reservoir and, aside from being a small stream, there is an ice pond on the stream a short distance below the plant. The city has been confronted with a suit for damages by the owner of the ice pond, because of alleged contamination of the ice by fuel oil from the Diesel-engine plant connected with the filtration plant.

Two lagoons were constructed to receive the wash water and sedimentation-basin sludge. The first lagoon, estimated by the writer to have a capacity of 300,000 to 350,000 gal, receives both wash water and sludge. It is constructed with an overflow, so that overflow liquor enters a canal, which in turn discharges back into the reservoir. An auxiliary spillway from the lagoon has also been provided, which would allow settled sludge and wash water to flow either into the canal or to a 12-inch concrete pipe, leading to the second lagoon below the canal but above the brook. There is no overflow from the lower lagoon and the settled sludge from the first lagoon is allowed to dry in the lower one. The lower lagoon has a capacity of about 450,000 gal, with an average depth of 2.5 ft. A fairly large surface area allows for quicker drying of the sludge. On the basis of two washes a day, the upper lagoon has a detention period of about 3 days. When one of the sedimentation basins is cleaned, the detention period is about 10 hours.

The sedimentation basins are cleaned about once every four months. During the process of drawing down the basin, as the liquid

becomes thick, the upper lagoon is by-passed to the lower lagoon. Some odor is noticeable for some distance. The accumulated sludge in the lower lagoon contains quite a little odor when the surface scum or layer is pierced. As yet only a small amount of sludge has been taken from the lower lagoon in the 7 years of plant operation, mainly to ascertain what the problem of cleaning the lagoon might be. Since the sludge is building up in depth, it may soon be necessary to excavate it.

The chief operator at this plant reports that, in his opinion, the use of activated carbon ahead of the sedimentation basin kept the sludge from compacting in the basin. The basin was more easily cleaned of sludge under these conditions. The writer has not attempted to correlate this observation with operation at other plants.

Plant E. This plant has a design capacity of 5 mgd, with a sedimentation basin divided into two basins, operated in parallel and having a detention period of 4 hours at design capacity. The average consumption is about 3 mgd. A small stream runs past the plant and meanders through a number of private properties containing pools. If wash water or sludge from the filtration plant were discharged into the stream, complaints would most certainly result because of nuisance conditions.

However, the city was fortunate in having a 12-inch cement pipeline to the city, which had been abandoned. This cement line was pressed into service and carries the wash water and sludge to a larger stream, about 5 miles below the plant. No difficulty has been experienced in the use of this line so far as clogging is concerned. The fall from the receiving chamber at the filtration plant to the Norwalk River is about 230 ft.

This office received one complaint about the discoloration of the river below the outfall. It is believed that the use of activated carbon resulted in some of the discoloration. Samples of water were collected above and below the outfall; the fears of the complainant, so far as health is concerned, were dispelled, and no further complaints have been received.

Plant F. The city in which this filtration plant is located operates a rapid sand filtration plant of a design capacity of 3 mgd, with a consumption of about 1 mgd. The sedimentation basin has a capac-

ity of 220,000 gal, with a detention period of 1.75 hours at design capacity but a little over 5 hours at this normal rate of consumption. The receiving stream for the wash water and sedimentation-basin sludge would offer sufficient dilution, normally, to eliminate nuisance conditions. However, a small pool used for bathing purposes is located just below the plant and the city operates a public bathing pool on the stream about ¾ mile below the plant.

The water department is therefore unable to discharge wash water into the stream and is also unable to clean the sedimentation basin during the bathing season. The wash water is discharged into a meadow below the plant, away from the stream, without apparent odor nuisance. This wash-water discharge seeps into the ground before reaching the stream. The sedimentation basin is cleaned just before the bathing season and not again until after the season is over.

The remaining eleven Connecticut plants are close enough to large streams to obtain the necessary dilution and far enough from permanent habitation so that no complaints have yet been received by the State Department of Health. There are several plants where the receiving stream is rather small and, if property is purchased and houses are constructed in the future near the discharge, nuisance conditions may result.

Table 2 is of some interest as showing the variation in the number of times the sedimentation basins are cleaned and the method of disposal of sludge. It is also of interest in indicating the number of plants from which complaints have been received. Complaints have been registered against eight of seventeen plants at some time or other. In some cases the basins would be cleaned more often if conditions of disposal were more favorable. Within reason, the more often the basins are cleaned, the better the operating results are likely to be. Maximum detention periods are obtained with clean basins and the treated water over the settled sludge is less affected with sludge in which no putrefaction has started. Unusual conditions sometimes occur when it may be desirable to dump a sedimentation basin. cleaned when operating conditions demand it, rather than when stream cleaned when operation conditions demand it, rather than when stream conditions allow it.

TABLE 2.—PRACTICE IN CLEANING BASINS

Plant	Number of cleanings a year	Method of disposal	Complaints	Remarks
A	2	Lagoon and small brook	Yes	Wait for good brook flow
B1	Winter—6 mos; summer—every 3 wks	Lagoon and small brook	Yes	
B2	2	Lagoon and small brook	Yes	
C	4	Sludge beds	Yes	New method proposed
D	3	Double lagoon	Yes	No complaint with double lagoon
E	2	Dilution	Yes	One complaint from discoloration
F	4-5	Dilution	Yes	Bathing on brook below plant
G	6	Dilution	No	Near salt water, no near residents
H	2	Dilution	No	Must be careful and wait for high brook flow
I	1-2	Dilution	No	Near salt water, no near residents
J	3-4	Dilution	No	Wait for good brook flow
K	Every 3d week	Dilution	No	Small sedimentation basin
L	4	Dilution	No	
M	5	Lagoon	No	Small plant, no near residents
N	4	Dilution	No	
O	Summer—every 2 mos	Dilution	Yes	Wait for good stream flow
P	1	Old sand filter	No	Filter in poor condition, no near residents

POSSIBLE REMEDIES

The review of the problems confronting several of the filtration plants in Connecticut may have suggested some possible remedies. Every plant presents a different set of conditions and the method of solving the difficulties for some plants may not solve those for other plants, even when many of the conditions are similar. The following suggestions, however, may serve as a guide in the further study of the waste-water disposal for a particular plant.

1. The best method of disposal of wash water and sedimentation-basin sludge, from the water-plant operator's standpoint, is to discharge it into a public sewerage system, if available. It may be economical in the long run to spend the necessary amount of money on a sewer extension to a filtration plant and even a pumping station to pump the waste water to a sewerage system. It is desirable to determine whether the existing sewerage system and treatment plant are capable of receiving the added load from the filtration plant. The sedimentation sludge would be received at the sewage treatment plant in slugs at certain intervals and might interfere with plant operation. This might be true particularly for a separate sludge-digestion plant, where minerals such as aluminum, if in relatively large quantities, might interfere with the normal sludge-digestion process.

2. A receiving stream large enough to furnish sufficient oxygen to stabilize the organic matter in the wash water and sedimentation-basin sludge would eliminate nuisance conditions and, unless other factors such as ice ponds and pools on the receiving stream entered the picture, this dilution should be a satisfactory method of disposal. When the dilution method is used and the stream is not overly large, consideration might be given to a controlled discharge of sludge from a sedimentation basin, so that the entire amount of sludge is not dumped into the stream at one time. This may even cause some change in the plant design, to allow the basin in the process of cleaning to be out of operation for a longer period than the usual 8 to 12 hours. It also suggests the consideration of designing a plant so that sludge may be drawn in small quantities at frequent intervals without placing the basin out of operation. So far, however, under present plant design, the filtration-plant operators appear to prefer drawing a basin down completely.

The book "Sewage Treatment" by Imhoff and Fair, published by John Wiley and Sons, Inc., contains a discussion on self-purification of streams as a result of sewage discharge and provides material for computing the amount of sewage a stream can receive under certain conditions without causing nuisance. The method takes into account the stream flow, temperature, dissolved oxygen in the river, the B.O.D. of the river, the oxygen condition of the sewage, and the desired saturation of dissolved oxygen in the river below the sewage

discharge. The oxygen balance may be determined by calculating the B.O.D. of the effluent plus that of the river and comparing it with the amount of oxygen supplied by the D.O. of the river plus the D.O. of the sewage plus that absorbed by re-aeration of the combined flow. Under some conditions it might be desirable to make such a computation in designing a plant, based on the necessary assumptions as to the expected characteristics of the sludge, and, in any event, if dilution is proposed, at least some investigation should be made as to the feasibility and the probable effect on the stream.

3. If a public sewerage system is not available and the receiving stream is small, treatment of the sludge and wash water is desirable. One Connecticut plant had seemed to solve this problem with sludge-drying beds, except for the fact that a sufficient amount of land had not been purchased to do away with complaints of very local odors. It would seem that land for a distance of at least 500 to 1,000 ft from the sludge bed should be acquired and this does not take into consideration the disposal of wash water, which is less obnoxious than the sludge but which may still cause difficulty. The sludge beds could be covered with glass, to lessen odor conditions and possibly hasten drying, but the cost is rather high.

4. There is always the possibility of further study on the treatment of the sludge. Possibly another chemical could be added to reduce the odors and also quicken the period of drying when sludge beds are used. Further study would seem desirable but there is considerable question in the writer's mind as to whether digestion of the filtration-plant sludge can be done satisfactorily, as in sewage sludge, because of the high mineral content.

5. Lagooning of sludge and wash water, if there are no houses in the vicinity or ice ponds, pools, etc., immediately below the discharge, appears to be satisfactory. Two lagoons appear to be more satisfactory than one, the first being used for primary settling and the second lagoon being allowed to receive the sediment from the wash water which is discharged to the first lagoon, as well as the thick sludge. The second lagoon may need no overflow and may need to be cleaned only once in several years. On the basis of experience in one of the Connecticut plants, the total capacity of the two lagoons may not need to be much more than half the total capacity of the sedimentation basin.

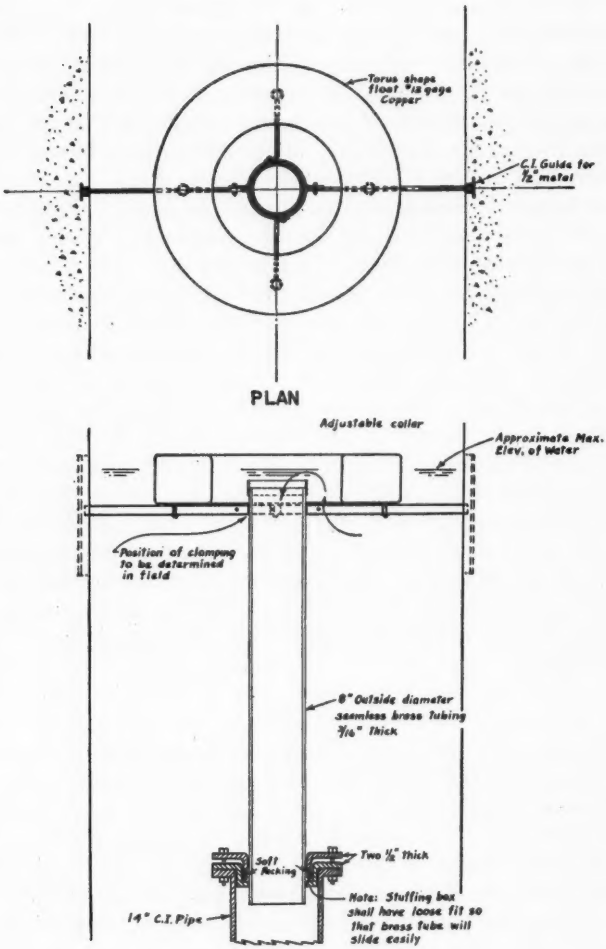
6. Decanting a lagoon or outside sedimentation basin can be done by removing stop logs by hand or operating a series of valves at different elevations. However, a floating weir would seem much more convenient. In Figure 2 is shown a sketch of a floating weir, used in connection with maintaining a constant rate of filtration at a slow-sand water filtration plant. While the writer has not seen one in operation to decant a sedimentation basin or lagoon, there does not seem to be any reason why such an arrangement cannot be used.

7. At some locations, satisfactory disposal of sludge or wash water from a rapid sand filtration plant may be very difficult. If the reservoir or lake is fairly large, pumping the sludge and waste water back to the upper end of the reservoir may solve the problem and will save water. Connecticut has had no experience along this line but apparently this has been done in several places in the United States. It would seem that certain controls should be set up, if pumping back to the reservoir is used. There should be regular microscopical examinations and certain physical and chemical tests at regular sampling points in the reservoir, as well as sludge soundings near the point of discharge to the reservoir. Sludge banks would, of course, be objectionable, because of the resulting decomposition of organic matter. There is also the possibility of additional algal growths from the sludge. Every effort should be made to assure that conditions will not result that cannot be easily taken care of at the filtration plant.

Conclusions

Although there seems to be a dearth of information with regard to the disposal of sedimentation sludge and wash water from rapid sand filtration plants, the writer has found that at many plants this is a sizable and sometimes vexing problem. Consideration as to methods of disposal should be given, when the plants are designed, and should be given the same rating in importance as the factors considered in causing the plant to operate successfully, in so far as turning out a good effluent is concerned.

While the writer probably has offered nothing new in the consideration of the problem, it is hoped the paper may prompt more thinking along the line of proper wash-water and sludge disposal.


Torus shape float 12 gage Copper
C.I. Guide for ½" metal
PLAN
Adjustable collar
Approximate Max. Elev. of water
Position of clamping to be determined in field
8" Outside diameter seamless brass Tubing 7/16" Thick
Soft Packing
Two ½" Thick
Note: Stuffing box shall have loose fit so that brass Tube will slide easily
14" C.I. Pipe
SECTION

FLOATING WEIR FOR DECANTING LAGOON

FIG. 2

Discussion

F. O. A. Almquist. Personally I would like to know if anyone has had any experience on pumping back sludge to the reservoir, and what the effect might be. That was done in Cambridge. I don't know whether it was discontinued or not; perhaps someone knows.

Thomas R. Camp (Boston, Mass.). Mr. Almquist mentioned that the coli count was zero in a number of sludges, although there was some in others. I wonder if he made any comparison between the coli coming into the settling tank and the coli in the sludge. What I am getting at is, was there any evidence that the coli was killed off in the sludge?

F. O. A. Almquist. No. As a matter of fact, these samples were collected before we had gone very far with this matter or we might have included some additional examinations, such as the wash-water tests, and so on. It is very likely that coliform organisms would be destroyed, however, in the sludge. In those plants using pre-chlorination, however, the water entering the sedimentation basins would be of good quality.

Thomas R. Camp. In regard to Cambridge, they are still wasting their sludge and wash water into Fresh Pond and, to the best of my knowledge, there is no observable effect there.

F. O. A. Almquist. Do you know whether that is just above the intake to the filtration plant?

Thomas R. Camp. Yes; around the point, the other end of the pond, some 1,000 or 1,400 ft away.

Harold W. Griswold (Hartford, Conn.). It would seem, having gone to a lot of expense to take this material out of the water, it would be a mistake to put it back again, wouldn't it?

F. O. A. Almquist. Not necessarily.

Thomas R. Camp. That is in regard to Cambridge?

Harold W. Griswold. Yes.

Thomas R. Camp. Fresh Pond is only a part of Cambridge's water supply.

Harold W. Griswold. If I am correctly informed, sludge never disappears.

F. O. A. Almquist. Never what?

Harold W. Griswold. Never disappears entirely.

F. O. A. ALMQUIST. You may have some sedimentation in the reservoir; there is no getting away from it.

HAROLD W. GRISWOLD. So that over a long period of years you would fill up the reservoir.

F. O. A. ALMQUIST. If you operated long enough you might. Of course you are getting silting of the reservoirs anyway. They add alum to the water at Springfield, I believe, on occasion, and they add alum to the New York City supply in the upper reservoirs sometimes, I believe. I have not heard that it has been injurious to those water supplies and the water in New York City, at least, is not filtered.

THOMAS R. CAMP. In the case of Cambridge, it is probably the lesser of the two evils. You do reclaim the water, which is one advantage.

HAROLD W. GRISWOLD. About 4% of the total, would you say?

F. O. A. ALMQUIST. Three to five; sometimes more, sometimes less. It happens to be 4% in this particular plant.

Has anyone else any other experience in regard to pumping sludge back into a reservoir?

ARTHUR L. SHAW (Boston, Mass.). At the Salem and Beverly filtration plant in Beverly, Mass., wash water and sludge were pumped into a lagoon, which was created by diking off a swampy area on the margin of the lake which supplies the water, so that, in effect, they were being pumped back to the lake. The dike is constructed in such a way that the water leaches back into the reservoir, and gradually that swampy area is being filled. These margin areas are good growing grounds for algae and it may be a good thought, perhaps, to dike off some of those areas and gradually fill them with sludge.

F. O. A. ALMQUIST. Are there any houses near the Salem-Beverly lake?

ARTHUR L. SHAW. Not very near, no.

F. O. A. ALMQUIST. Is there much odor in connection with that matter?

ARTHUR L. SHAW. I don't think so.

WILLIAM W. BRUSH (New York, N. Y.). In New York, at the Kensico Reservoir, alum is added for a variety of reasons. Since the Schoharie water came in and was used as a part of the supply,

the treatment has continued, I should say, on an average of about four months each year. The depth of the sludge is about a maximum of 6 in. in the upper part of one branch of the Kensico Reservoir. It extends down for a distance of about a half mile from the intake. From the point where this water flows in, the total distance down to the outfall from the reservoir is 3½ miles. There has not been any evidence of that sludge being in any way disturbed by wind action, wave action or otherwise. It stays quiescent. There has not been in any way a detriment to the quality of the water, as far as we have been able to determine. And the time it would require to fill there would be several hundred or thousand years, and most of us are not worrying about what may happen after that time.

ARTHUR L. SHAW. There is one rather significant difference between the pollution of a stream by the effluent from a sewage treatment plant and that by the sludge or wash water from a water plant. In the case of the sewage plant you are introducing extraneous matter; in the case of a water plant you are returning, as far as the organic and putrid matter is concerned, only the material which you took out of the same water, if you get my point. Of course you are adding a certain inert chemical, such as alumina and calcium and some carbon. But it might be argued that you are not polluting the stream to any extent. Possibly the law would hold that, since you have taken it out and held it long enough for it to putrefy and have then put it back, you have polluted the stream. But the difference between sewage and sludge from the water plant is significant.

HAROLD W GRISWOLD. Might it not be that the rate of return would enter into that argument—that if you return it at the same rate that you took it out you have not changed the character of the stream, but if you hold it back for two weeks and then throw it in in a chunk, so to speak, you are changing the natural character of the stream?

THOMAS R. CAMP. So far as certain organisms are concerned, you are not changing the quality of the water.

HAROLD W. GRISWOLD. It is interesting to know that the wash water and the sludge from a slow sand plant have to be disposed of. It does not seem particularly bad, but it would not do to discharge it directly into the stream. In our own case, we are along a canal

and we dump the whole business into that canal and then skim off the top water, and about once in 7, 8 or 10 years they do just what you suggest, Mr. Shaw, they take this sludge or silt and pump it over swampy areas. That of course stimulates the growth of trees in that area. Usually, if you change much the level of the land around trees, they do not flourish but in this case the growth was stimulated.

F. O. A. ALMQUIST. You do not have the minerals, though, in the slow sand filtration plant.

HAROLD W. GRISWOLD. No chemical.

F. O. A. ALMQUIST. But you have the organic matter. It would be an accumulation of vegetation.

FREE-RESIDUAL CHLORINATION AT THE NEW HAVEN WATER COMPANY

BY S. JACOBSON* AND M. S. WELLINGTON†

[*Read September 17, 1946.*]

THE New Haven Water Company serves about 250,000 consumers in New Haven and vicinity. In the year 1945, the average daily consumption of water was 33 mil gal, obtained from 16 reservoirs, of which 10 are distributing reservoirs, while the remainder are used for diversion and storage purposes. The location of all supplies is shown on Plate I. Each of the supplies is treated with chlorine very soon after leaving the reservoir. Re-chlorination is practiced at one booster station, located between the towns of West Haven and Milford. In all, twelve chlorinators are operated to produce free available-chlorine residuals (1). This method of treatment was introduced in all supplies between June and October, 1944.

A paper discussing the over-all effects of free-residual chlorination on the supplies of the New Haven Water Co. will appear in the Journal of the American Water Works Association (2). In the present report, we have limited our discussion of free-residual chlorination to eight individual supplies, which either represent special problems or appear to be typical in their behavior. The average chemical analyses of these supplies are shown in Table 1, to indicate the different types of water under consideration.

Chlorination Data. Daily records are kept by the treatment-plant operators. The chlorine-dosage rates for Figures 1 to 8 are averages, computed from the water consumption and the weight of chlorine used during the month. The plant operators perform daily ortho-tolidine tests, using chlorine comparators of the Hellige type. Previous to free-residual chlorination, the practice was to determine the chlorine residual after full color development, usually in 5 minutes. A chlorine residual of 0.2 ppm after 10 minutes' contact was recommended at that time.

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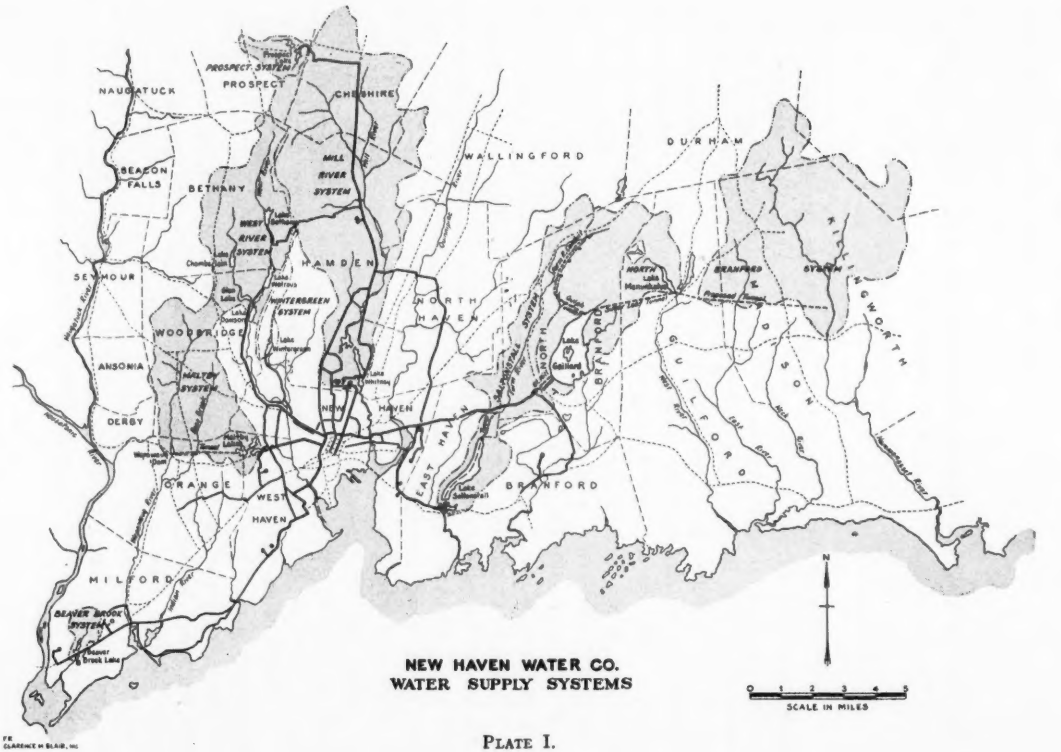

NAUGATUCK
PROSPECT
CHESHIRE
PROSPECT SYSTEM
BEACON FALLS
BETHANY
MILL RIVER SYSTEM
WALLINGFORD
DURHAM
WEST RIVER SYSTEM
HAMDEN
SEYMOUR
WHITEGREEN SYSTEM
NORTH HAVEN
BRANFORD
WOODBRIDGE
ANSONIA
DERBY
NEW HAVEN
EAST HAVEN
ORANGE
WEST HAVEN
BRANFORD
GUILFORD
MILFORD
BEAVER BROOK SYSTEM
NEW HAVEN WATER CO.
WATER SUPPLY SYSTEMS
N
0 1 2 3 4 5
SCALE IN MILES

PLATE I.

TABLE 1.—AVERAGE CHEMICAL ANALYSES OF TREATED SUPPLIES OF NEW HAVEN WATER CO.

	Saltonstall	Gaillard (with ammoniation)	Gaillard	Woodbridge (with ammoniation)	Woodbridge	Bethany	Maltby No. 1	Maltby No. 2	Wintergreen (with lime)	Wintergreen (with metaphosphate)	Whitney
pH	7.5	7.2	7.1	6.9	6.7	6.4	6.9	6.8	9.4	6.8	6.9
					(Parts per million)						
Turbidity	3	1	2	3	3	3	2	2	5	5	1
Color	12	12	10	25	24	26	15	18	31	27	11
Ammonia (Nitrogen)	0.004	0.067	0.003	0.056	0.010	0.005	0.004	0.008	0.008	0.005	0.005
Albuminoid (")	0.124	0.078	0.078	0.100	0.098	0.125	0.093	0.117	0.118	0.175	0.043
Nitrite (")	0.001	0.002	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nitrate (")	0.12	0.02	0.08	0.14	0.09	0.02	0.09	0.22	0.06	0.00	0.90
Total Hardness ($CaCO_3$)	53	34	34	19	21	17	29	30	39	23	49
Alkalinity (")	40	23	22	9	8	7	18	16	24	7	33

With the introduction of free-residual chlorination, the procedure is to collect a sample of chlorine-treated water in a glass-stoppered, pyrex bottle, which is allowed to stand for a sufficient length of time to obtain a contact period of 10 minutes. A portion of the sample is then poured into the cell of the comparator to which has been added the ortho-tolidine reagent. The color that is immediately produced is read as the flash chlorine residual. The reading is again taken in 5 minutes and recorded as the chlorine residual, which has been used in making the graphs.

Laboratory Control. Our preliminary procedure in the introduction of free-residual chlorination to a supply is the estimation of required chlorinator capacity. The usual laboratory jar tests are made at least twice a year and whenever indicated by unusual conditions. We always use for this purpose a freshly prepared chlorine solution, obtained from the discharge of a chlorinator and standardized by the starch-iodide method.

The proper dosage of chlorine is based on the laboratory method described by Griffin (3). Increasing doses of diluted chlorine solution are thoroughly mixed with 500-ml samples of water in pyrex, glass-stoppered bottles. The increase in dosage for each of a series of ten bottles is usually about 0.2 ppm. In this procedure, the criterion for the required dosage is that which gives a flash residual of free available chlorine equivalent to 85% of the 5-minute residual after the proper contact period with chlorine. For our purposes, a contact period of one hour at room temperature appeared to be most satisfactory.

When these studies are made, the taste and odor characteristics are carefully noted by two or more workers. With increasing chlorine-dosage rates, tastes and odors, when present, usually undergo various changes. At low chlorine-dosage rates, disagreeable odors and tastes are either disclosed or intensified. At higher rates, where free available-chlorine residuals are obtained, there exists a more or less narrow range of satisfactory water with perhaps a slight chlorinous odor. At still higher rates, this is followed in turn by water with chlorinous odor and metallic taste.

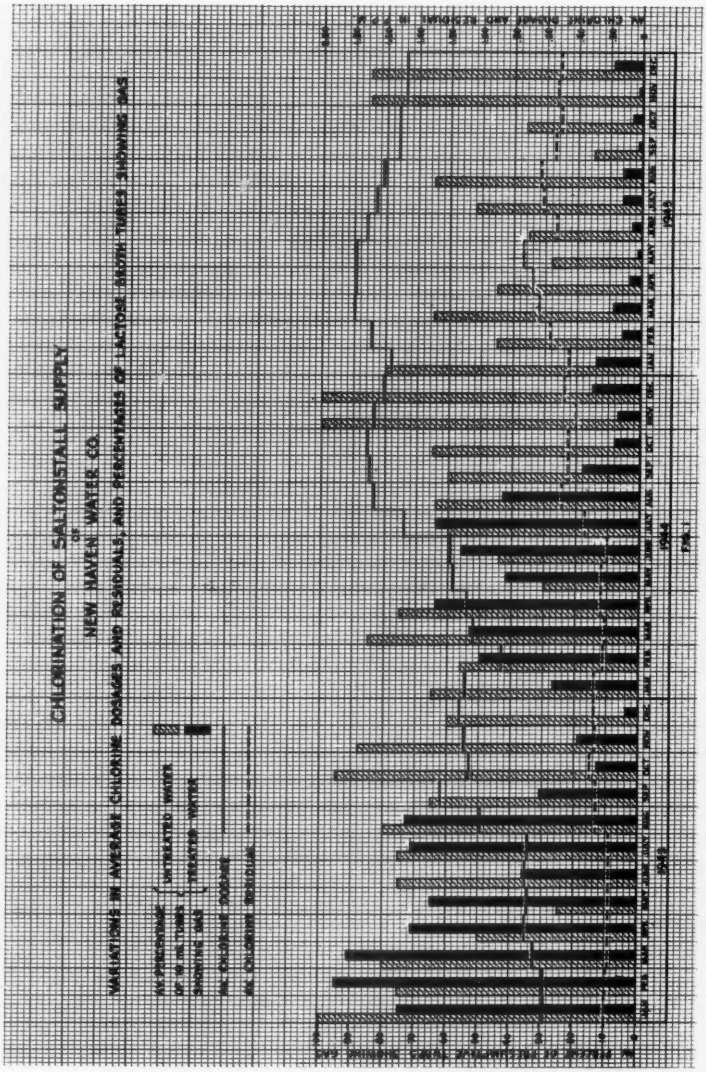
The bacteriological procedures are in accordance with "Standard Methods of Water Analysis" (4). Samples from the distribution

systems for bacteriological analysis are collected from taps maintained by the company. The locations of these taps will be given under the discussion of the individual supplies. Sodium thiosulfate is added to the sampling bottle before sterilization, in accordance with the recommendation of the U. S. Public Health Service (5). The untreated water samples are either collected from taps before the point of chlorination or dipped from the reservoirs. Within two hours after the collection, five lactose-broth tubes are inoculated with 10-ml portions of the water sample. The 48-hour records of gas formation in the presumptive test are used in this discussion.

Lake Saltonstall Supply has a distributing reservoir with a capacity of 1,100 mil gal. The shore is owned by the company. The main line of the New York, New Haven and Hartford Railroad is at the lower end of this reservoir and presents a potential pollution hazard. The watershed consists of 13.3 sq mi and is moderately populated, about equally with dwellings and farms requiring close sanitary supervision. The water is pumped from this reservoir by means of centrifugal pumps having a maximum total capacity of 9 mgd.

In the treatment of this supply, chlorine is applied to the suction well by means of a manually controlled, solution-feed chlorinator. The sampling point for residual-chlorine determinations is about 100 ft from the point of application of the chlorine. The samples for bacterial analysis are collected from a point in the system two miles from the pump house. Residual chlorine at this sampling tap was not observed until the introduction of free-residual chlorination, and since that time free available-chlorine residuals varying from 0.05 to 0.25 ppm, depending on conditions, have been observed.

Figure 1 shows our chlorination experiences with the Lake Saltonstall supply. From January through July, 1943, the graph indicates our previous practice. The chlorine dosage averaged 0.66 ppm and the chlorine residual averaged 0.18 ppm. The proportion of tubes showing gas in the samples of chlorinated water averaged 72% and the corresponding figure for untreated water averaged 69%. From August, 1943, through June, 1944, chlorinator capacity was insufficient for free-residual chlorination under all conditions but some reduction in gas tubes was noted. The tubes showing gas from samples of the untreated water averaged 68%, while those from samples of the treated water averaged 39%.


CHLORINATION OF SALTONSTALL SUPPLY
OF
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGES AND RESIDUALS, AND PERCENTAGES OF LACTOSE-BROTH TUBES SHOWING GAS
AT CONNECTICUT AVENUE
AT FILTERS
SECTION OF CITY SUPPLIED
AT CHLORINE HOUSE
AT CHLORINE HOUSE
AT CHLORINE HOUSE
AT CHLORINE HOUSE

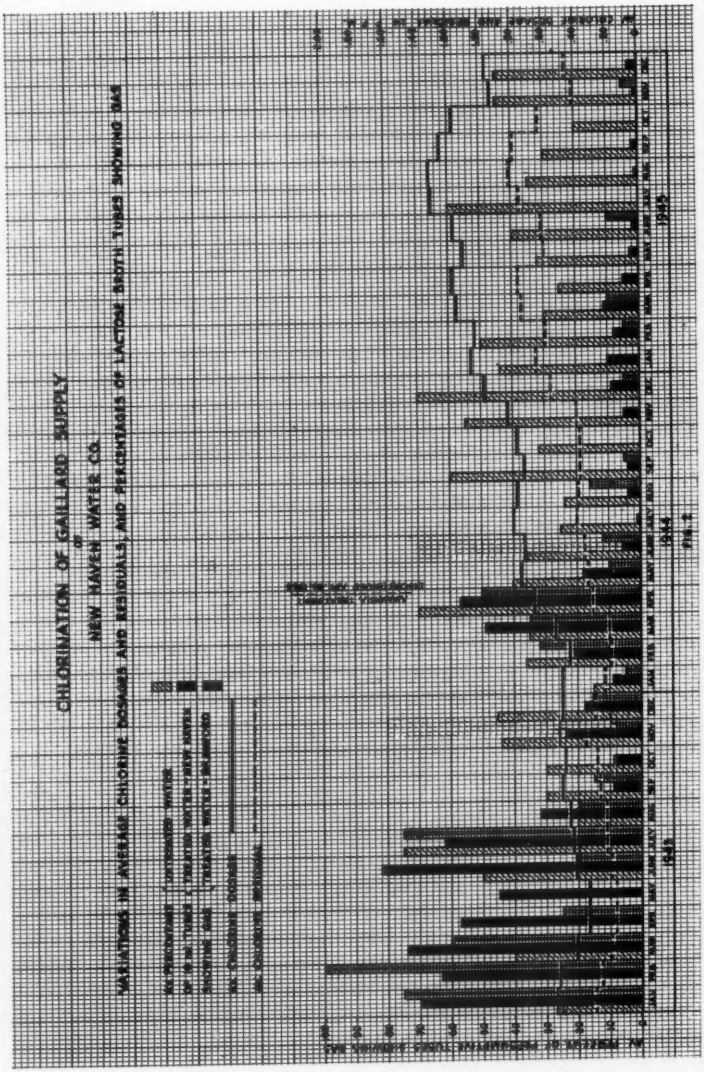
A new chlorinator has been in service since June, 1944, and has operated to give free available-chlorine residuals. We try to adjust the rate of chlorine to the varying rate of pumpage resulting from variations in distribution-system pressures. Growths in the suction well and suction pipe may account for the delay in the decrease in the percentage of gas tubes from July through September, 1944. Subsequent to this period, the chlorine dosage averaged 1.64 ppm and the residual chlorine averaged 0.55 ppm. The proportion of gas tubes averaged 60% in samples from untreated water and 6% in samples from the treated water.

Lake Gaillard Supply has a distributing reservoir with a capacity of 15,642 mil gal. A smaller reservoir, with a capacity of 203 mil gal for diversion and storage, empties into Lake Gaillard. The watershed area of 17.3 sq mi is largely owned by the company, while the remainder is sparsely inhabited. Water flows from this supply by gravity in quantities varying from 9 mgd to 22 mgd.

In the treatment of this supply, ammonia and chlorine were used in the ratio of one to four and were applied to the main by means of Venturi-controlled, dry-feed ammoniator and solution-feed chlorinator. The sampling point for residual-chlorine determinations is about 200 ft from the point of chlorine application. The samples for bacterial analysis are collected from the New Haven system, at a point seven miles from the chlorinator, and from a sampling point on a separate line to Branford, five miles from the chlorinator.

Figure 2 shows our chlorination experiences with this supply. From January, 1943, to April, 1944, the graph indicates our previous practice. Ammoniation was successfully used on this supply, to eliminate the coliform bacteria in the distribution system, but the percentage of tubes showing gas was high. The chlorine dosage averaged 0.47 ppm and the residual chlorine averaged 0.23 ppm. The tubes showing gas in samples from the untreated water averaged 32%. The gas tubes averaged 43% from the New Haven samples and 33% from the Branford samples. Ammoniation was discontinued on April 26, 1944.

A significant reduction in the percentage of gas tubes has been observed since May, 1944. The chlorine dosage averaged 1.0 ppm and the residual chlorine averaged 0.55 ppm. The proportion of


CHLORINATION OF GAILLARD SUPPLY
OF
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGE AND RESIDUAL, AS PERCENTAGES OF LACTOSE BROTH TUBES SHOWING GAS
Fig. 3.

gas tubes from the samples of untreated water was 40%. The tubes showing gas averaged 5% from the New Haven samples and 4% from the Branford samples. A chlorinator of larger capacity was installed in January, 1945.

Before the use of free-residual chlorination, combined available-chlorine residuals (1) in the New Haven branch of the system were about 0.10 ppm, and in the Branford branch, 0.00 ppm. Since the introduction of free-residual chlorination, free available-chlorine residuals of about 0.25 ppm have been noted in New Haven and 0.10 ppm in Branford.

Woodbridge Supply is a gravity system, which includes two distributing reservoirs—Glen Lake and Watrous Lake—having capacities of 197 mil gal and 725 mil gal, respectively. Glen Lake has a watershed area of 5.8 sq mi, including Lake Chamberlain, a storage reservoir of 164-mil gal capacity. Lake Watrous has a watershed area of 7 sq mi, including Lake Bethany, a storage reservoir of 650-mil gal capacity. Lake Bethany is also a distributing reservoir for one of our systems, known as the Lake Bethany supply, which will be discussed later. The watershed area is mostly woodland and pasture land, with a few private homes and farms. The shoreline of the reservoirs and most of the main brooks are owned by the company.

The water flows from the Woodbridge supply in quantities that vary from 2 mgd to 12 mgd. For several years previous to 1944, chlorine-ammonia was used on this supply. The ammonia was added to the water by means of automatic dry-feed equipment, at a point 100 ft in advance of the addition of chlorine. The ratio of chlorine to ammonia was six to one. Chlorine is added to the water below a Venturi tube. The chlorinator has been used to maximum capacity but this has not been sufficient to furnish the required amount of chlorine for free-residual chlorination at all flows and with varying water quality. New equipment of sufficient capacity is now being installed.

The sample of water for residual-chlorine tests is collected 200 ft from the point of application of chlorine. The samples of water for bacterial analysis are collected at a point 3½ miles from the chlorinator. During ammoniation, combined available-chlorine residuals at the bacterial sampling tap were about 0.10 ppm. When flow condi-

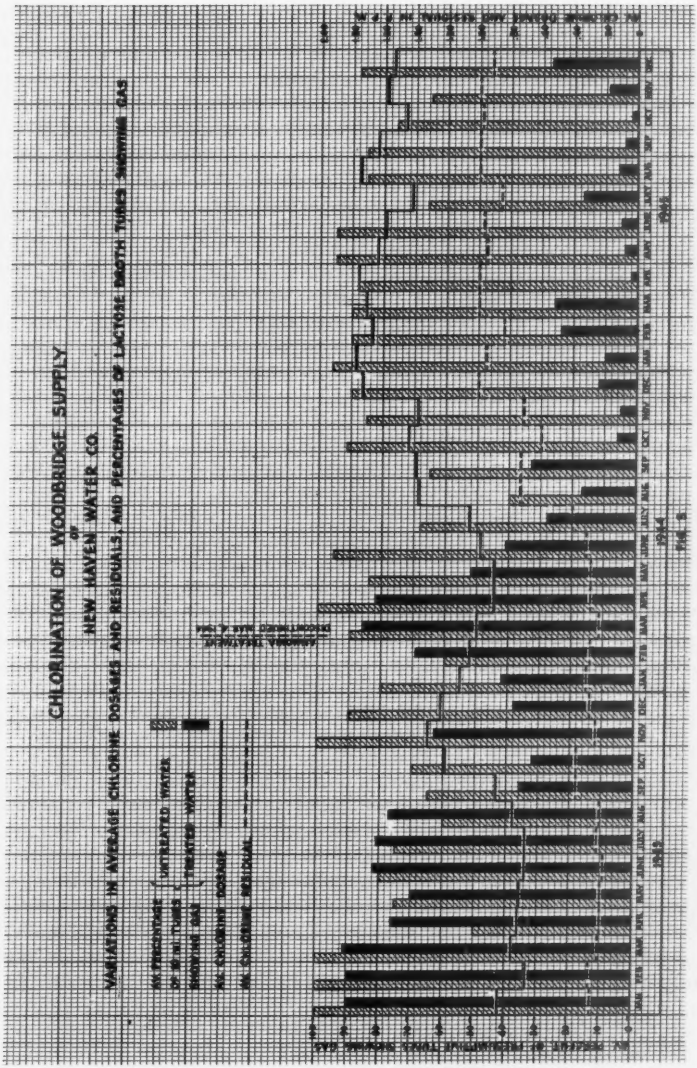
tions are low enough to allow free-residual chlorination, the free available-chlorine residuals at this point are about 0.2 ppm.

Reference to Fig. 3 will show that, during the period from January, 1943, to March, 1944, when ammoniation was practiced, the residual chlorine remained nearly constant, even with increasing chlorine-dosage rates. From January, 1943, through July, 1944, the chlorine dosage averaged 0.94 ppm and the chlorine residual averaged 0.26 ppm. The gas tubes from samples of untreated water averaged 81% and from samples of treated water 65%. Since August, 1944, a further increase in the chlorine-dosage rate resulted in a much higher residual. The chlorine dosage averaged 1.58 ppm and the chlorine residual averaged 0.89 ppm. The proportion of gas tubes from samples of untreated water averaged 82% and from samples of treated water 12%. The low points in February, July and December, 1945, in the residual curve, with the corresponding peaks in percentage of tubes showing gas, are due to insufficient chlorinator capacity at high flows. Due to a delay in obtaining a new disc for the comparator, with readings higher than 1.0 ppm, residuals in 1945 should be somewhat higher than the 1.0 ppm shown.

Lake Bethany Supply is obtained from a distributing reservoir with a capacity of 650 mil gal. The watershed area of 3.8 sq mi is also part of the watershed area for Lake Woodbridge.

Chlorine is applied by means of an automatic solution-feed chlorinator, actuated by a Venturi tube. The water flows from the reservoir by gravity into two standpipes, which are about 5 miles from the chlorinator. The height of water in these standpipes is controlled by an altitude valve, with the result that there are abrupt changes in flow from 0.1 mgd to 3.5 mgd. The peak flows last about two hours and the low flows about three hours. This sudden change of flow is a difficult chlorinating problem. A chlorine meter-tube that would give the recommended residual of 0.2 ppm on the high flows was so large that, regardless of frequent chlorinator adjustments in 1943 and the early part of 1944, complaints of chlorine taste and odor were numerous during low flows. After the introduction of free-residual chlorination, with higher dosage at all flows, this difficulty disappeared.

The samples of treated water for residual determination are collected 200 ft from the point of chlorine application. The samples


CHLORINATION OF WOODBRIDGE SUPPLY
OF
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGES AND RESIDUALS AND PERCENTAGES OF LACTOSE BOTH TYPES SHOWING GAS
1943
1944
1945

for bacterial analysis are collected about 4.5 miles from the chlorinator. The free available-chlorine residuals observed at the latter sampling point are now usually 0.15 ppm.

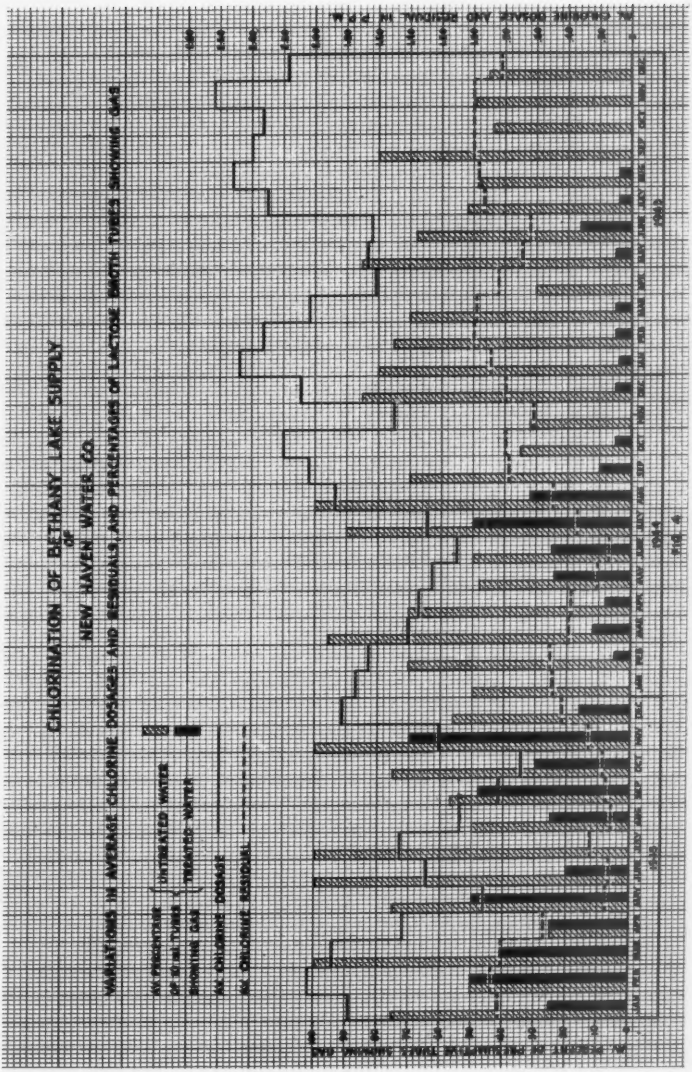
The results of the examinations are shown in Figure 4. From January, 1943, through July, 1944, the irregularities in chlorine-dosage rates were mainly due to chlorinator operating difficulties. The chlorine dosage averaged 1.38 ppm and the chlorine residuals averaged 0.38 ppm. The proportion of gas tubes from the untreated water samples averaged 70% and from samples of treated water 28%.

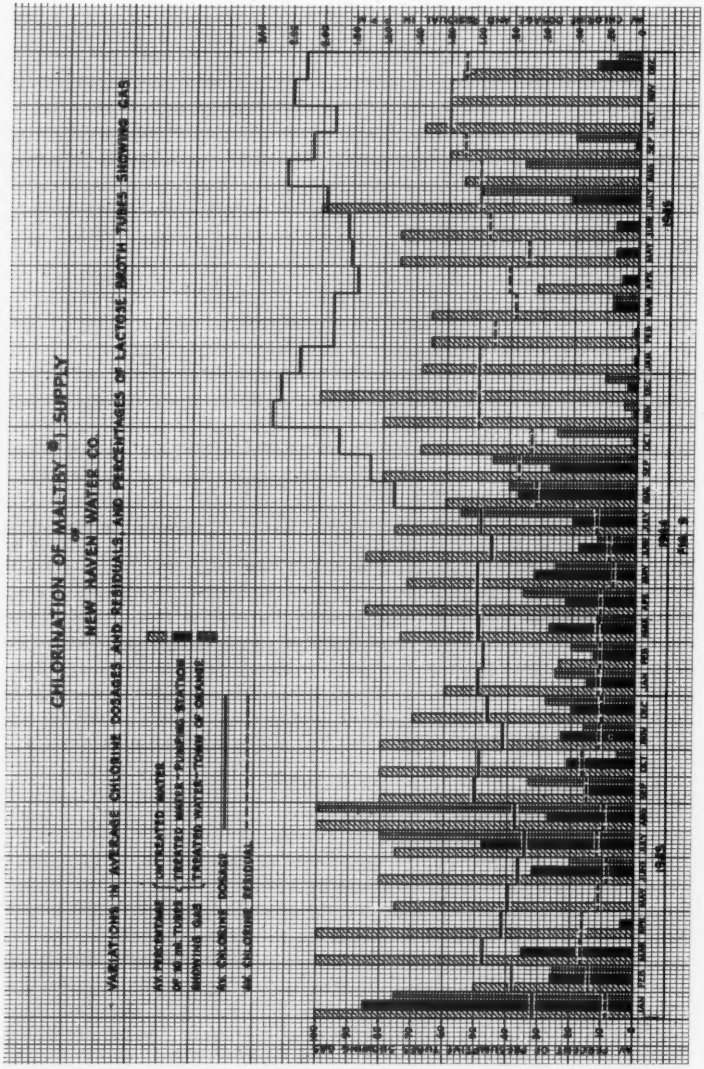
Free-residual chlorination has been practiced since August, 1944. Due to delay in obtaining a new disc for the chlorine comparator with readings higher than 1.0 ppm, residuals in 1945 at times should be somewhat higher than 1.0 ppm, as shown. The average chlorine dosage was 2.1 ppm and the chlorine residual averaged 0.84 ppm. Gas tubes from the untreated water samples averaged 62% and averaged 6% from treated water samples.

Maltby Lake No. 1 Supply is pumped from a distributing reservoir having a capacity of 52 mil gal. The watershed area is 10 sq mi, including Maltby Lakes No. 2 and No. 3 as storage reservoirs. The capacity of Maltby Lake No. 2 is 127 mil gal and Maltby Lake No. 3 has a capacity of 82 mil gal. The company owns all of the watershed area adjacent to the reservoirs and the remainder is moderately populated, about equally with farms and suburban homes. Some drainage can be expected from a State highway which runs along one edge of the reservoir.

Manually controlled, solution-feed equipment adds chlorine to the water in the suction main at a point 15 ft from the pumps. Each of the two centrifugal pumps, which pump into the system and into a standpipe about a mile away, has a capacity of 1.4 mgd. The fluctuations in rate of pumping are so slight that a constant setting can be maintained in the chlorinator.

The sampling point is in the pumping station, about 25 ft from the pumps. The samples for residual chlorine are taken during pumping and the sample for bacterial analysis is collected about 18 hours after the pump has been shut down. Samples are also collected from a sampling point in the town of Orange, about 4 miles from the chlorinator. The results of the analyses are shown in Figure 5. From


CHLORINATION OF BETHANY LAKE SUPPLY
OF
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGES AND RESIDUALS AND PERCENTAGES OF LACTOSE BACTERIA SHOWING GAS
AV. CHLORINE DOSAGE
AV. CHLORINE RESIDUAL
1913
1914
FIG. 4


CHLORINATION OF MALTBY LAKES SUPPLY
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGES AND RESIDUALS AND PERCENTAGES OF LACTOSE BROTH TUBES Showing Gas
AVERAGE DAILY PUMPAGE IN MILS.
PERCENTAGE OF GAS TUBES (LACTOSE BROTH) SHOWING GAS
AVERAGE DOSAGE
AVERAGE RESIDUAL
PARTS PER MILLION
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950

January, 1943, through July, 1944, the chlorine dosage was fairly uniform, averaging 0.88 ppm, and the residuals averaged 0.23 ppm. There were no residuals in samples for bacterial analysis. The proportion of gas tubes averaged 25% from the samples of treated water, collected at the pumping station, and 30% from the samples of treated water collected in Orange. Tubes showing gas from the untreated water samples were 77% of the total.

Since August, 1944, free-residual chlorination has been practiced. The chlorine dosage averaged 1.97 ppm and the residual averaged 0.93 ppm, with the result that there has been a marked decrease in gas-forming organisms. Tubes showing gas averaged 8% in samples from the pumping station and averaged 14% in samples from the town of Orange. During this period, the proportion of tubes showing gas from the untreated water samples was 69%.

The chlorine-dosage rate during April to June, 1945, was reduced for experimental purposes. This was followed by an increase in the percentage of gas tubes in July, 1945. When the chlorine-dosage rate was increased in August, 1945, no gas-forming organisms were found in the pumping-station samples but a slower decrease in the percentage of gas tubes was observed in the samples from Orange. In this connection, it should be noted that at the pumping station a free available-chlorine residual of 0.50 ppm is usually observed, when the bacterial samples are collected, but there is no residual chlorine at the Orange sampling tap.

Maltby Lake No. 2 Supply is a gravity system that includes a distributing reservoir with a capacity of 127 mil gal and a watershed area of 10 sq mi, including Maltby Lake No. 3, a storage reservoir of 82-mil gal capacity. This watershed area makes up part of the Maltby Lake No. 1 watershed but does not include the State highway, previously mentioned. The Maltby Lake No. 2 Supply, with flows varying from 0.5 mgd to 4.5 mgd, is treated by an automatic solution-feed chlorinator, applying chlorine in the main at the outlet of a Venturi tube.

Water samples for the determination of residual chlorine and for bacterial analysis are taken from a tap, 175 ft from the point of application of the chlorine, after about three minutes' contact between the chlorine and the water. This is done because no other bacterial

sampling tap is available for this supply before it mixes with other supplies.

From Figure 6 it can be seen that a steady increase in the chlorine-dosage rates occurred from January, 1943, through July, 1944, without any increase in the residual chlorine. This increase in chlorine-dosage rates was made to eliminate coliform bacteria that were occasionally found in the supply. During this period, the chlorine dosage averaged 0.90 ppm and the chlorine residual averaged 0.21 ppm. The gas tubes averaged 74% in samples from the untreated water and 54% in samples from the treated water.

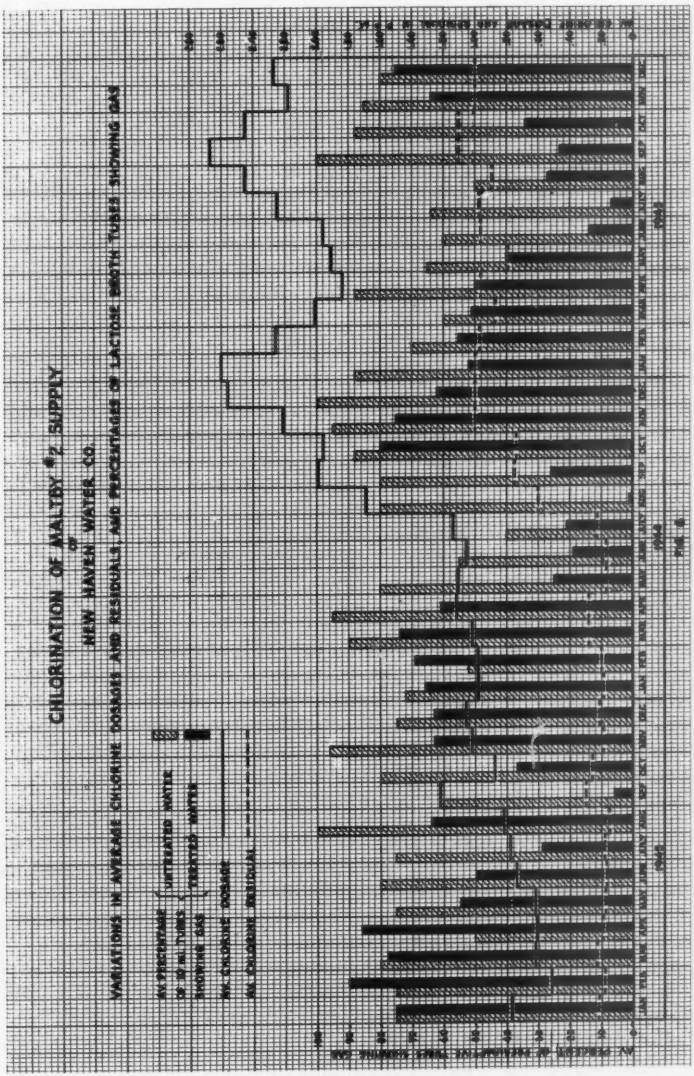
Free-residual chlorination was started in July, 1944, when the capacity of the chlorinator was doubled. The chlorine dosage has averaged 2.2 ppm, with average chlorine residuals of 0.92 ppm. The proportion of tubes showing gas averaged 79% from the untreated water samples and 43% from the treated water samples.

The peaks in the dosage rates during December, 1944, to January, 1945, and in September, 1945, are not clearly indicated in Figure 6 by correspondingly high points in the residuals, because of the inadequate range in our chlorine comparator at that time. The low average chlorine-dosage rates in March to June, 1945, were caused by high flows of water beyond the capacity of the chlorinator.

Maltby No. 2 Supply is the only one in which a marked reduction in the percentage of tubes showing gas was not observed, but this is not surprising, in view of the short period of contact of the chlorine with the water. Experimental work has indicated that a longer period —about 30 minutes—is necessary to eliminate the gas-forming bacteria in this supply. It is interesting to note in Figure 6 that the lowest percentage of tubes showing gas occurred during the summer, when higher temperatures appear to have accelerated the germicidal action of chlorine. Variations in the bacterial flora may also have been involved.

Lake Wintergreen Supply has a distributing reservoir with a capacity of 100 mil gal and a watershed area of 1.8 sq mi, which has no known source of pollution and is mostly owned by the company. The water flows by gravity in quantities varying from 0.2 mgd to 3 mgd.

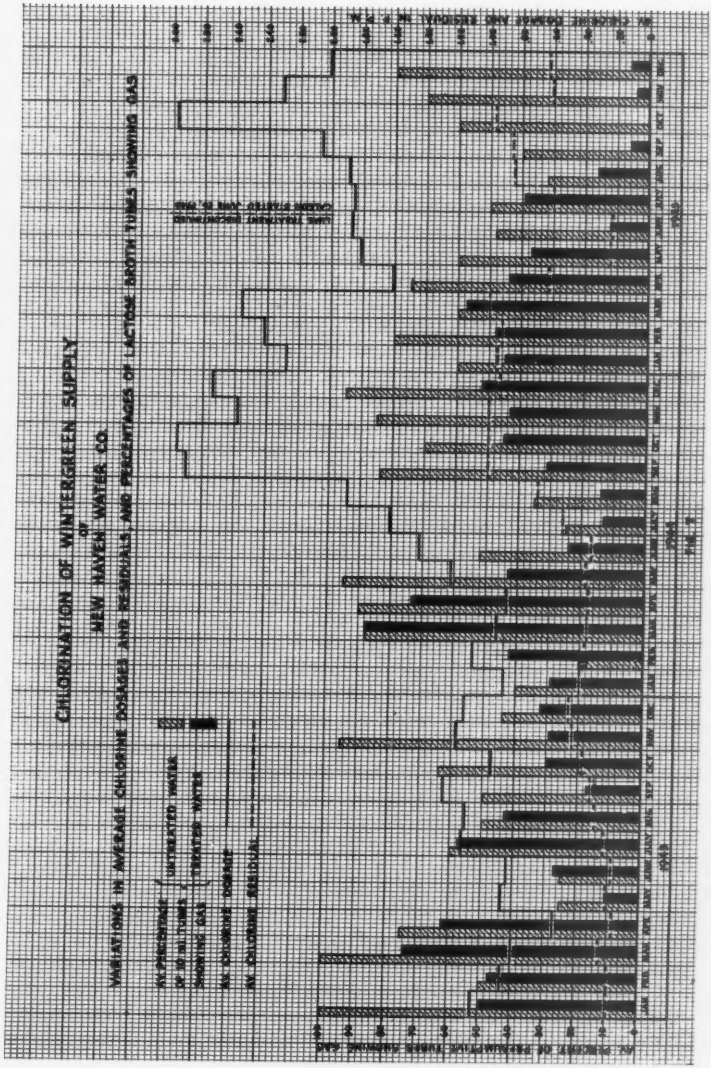
The untreated water is corrosive, with the pH varying from 5.9


CHLORINATION OF MALTBY #2 SUPPLY
OF
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGES AND RESIDUALS AND PERCENTAGES OF LACTOSE BROTH TUBES SHOWING GAS
IN DOSAGE
IN RESIDUAL
IN CHLORINE RESIDUAL
FILTERED WATER
RAW WATER
1915
1916

to 6.9, so that for some years lime was added. The average chemical analysis of the treated water at that time is shown in Table 1. The addition of lime introduced two factors which hampered the use of high doses of chlorine: first, the addition of chlorine to the lime-treated water at times gave a very bad iodine-like taste; secondly, it raised the pH to a point where germicidal action was retarded. Lime treatment was discontinued and sodium hexametaphosphate (Calgon) was substituted on June 22, 1945. The average chemical analysis of the water with this treatment is shown in Table 1.

Chlorine is fed by means of an automatic solution-feed chlorinator, which required an increase in capacity when free-residual chlorination was started and again later when more chlorine was needed. The point of chlorine application is 30 ft downstream from a Venturi. The lime and, later, the hexametaphosphate were added 15 ft downstream from the Venturi. The sample of water for residual determinations is collected 300 ft from the point of chlorine application. The sample for bacterial analysis is taken from a tap two miles from the treatment house.

Figure 7 shows that from January to June, 1943, the chlorine dosage was maintained so as to give no more than 0.2 ppm of residual chlorine, in order to avoid the iodine-like tastes. This was followed by higher residuals without taste complaints. From January, 1943, through May, 1944, the chlorine dosage averaged 0.98 ppm and the chlorine residual averaged 0.30 ppm. Gas tubes averaged 63% in samples from the untreated water and 44% in samples from the treated water. To improve the bacterial results, from June, 1944, through June, 1945, the chlorine dosage was increased and averaged 2.2 ppm, and the chlorine residual averaged 0.73 ppm. The proportion of gas tubes averaged 71% in samples from the untreated water and 36% in samples from the treated water. When sodium hexametaphosphate was substituted for lime, the chlorine dosage averaged 2.2 ppm and the residual averaged 0.75 ppm. Gas tubes averaged 55% in samples from the untreated water and 12% in samples from the treated water. The increased chlorine-dosage rate in October, 1945, was adopted to reduce the total bacterial count but the resulting chlorinous tastes and odors indicated the advisability of lower chlorine-dosage rates. Where formerly chlorine residuals were not observed at the sampling


CHLORINATION OF WINTERGREEN SUPPLY
OF
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGE AND RESIDUALS, AND PERCENTAGES OF LACTOSE BROTH TUBES SHOWING GAS
PER CENTAGE OF 10 CC. TUBES SHOWING GAS
UNTREATED WATER
TREATED WATER
PER CHLORINE DOSAGE
PER CHLORINE RESIDUAL

point for bacterial analysis, free available-chlorine residuals of 0.05-0.10 ppm are now obtained.

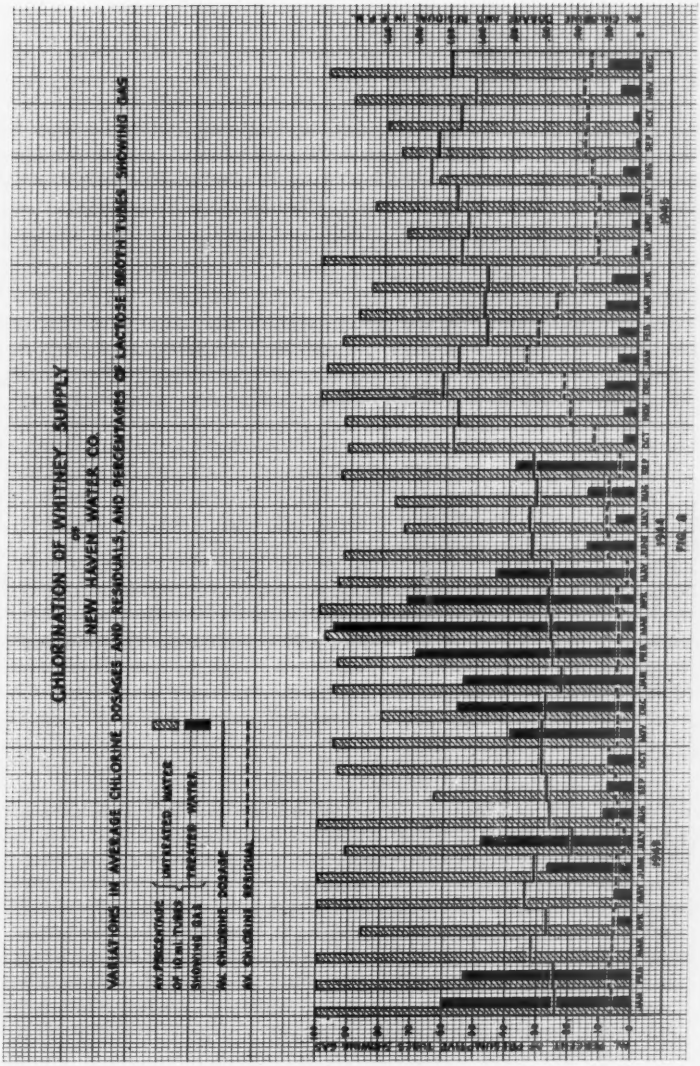
Lake Whitney Supply is pumped after passing through a slow sand filter. Lake Whitney is a distributing reservoir, having a capacity of 258 mil gal and a watershed area of 37.7 sq mi. The land bordering the reservoir and the main feeder stream is owned by the company. The watershed is densely populated but the part that is close to the reservoir is sewered. Sanitary conditions are such that filtration is necessary. The filtered water is chlorinated by means of a manually operated, solution-feed chlorinator. It is then stored in a covered, clear-water basin of 750,000-gal capacity, from which it is pumped by centrifugal pumps with a maximum total capacity of 16 mgd. The normal flow through the plant is from 1 mgd to 10 mgd.

The samples collected for residual chlorine and bacterial analysis are taken from the discharge of the pumps. The Lake Whitney Supply is the only one from which the residuals are taken after a contact period of about one hour. The results are shown in Figure 8. From January, 1943, to September, 1944, the chlorine dosage averaged 0.56 ppm and the chlorine residual averaged 0.11 ppm. The proportion of gas tubes averaged 92% in samples from the untreated water and 34% in samples from the treated water.

Following the hurricane of September, 1944, free-residual chlorination was introduced. The chlorine dosage averaged 1.12 ppm and the chlorine residual averaged 0.39 ppm. Tubes showing gas averaged 85% in samples from the untreated water and 6% in samples from the treated water.

The high residuals during the winter of 1944-45 appeared to be a seasonal effect, obtained when the chlorine dosage was more or less constant. This was followed by a period during which a fairly constant chlorine residual of 0.35 ppm was maintained, resulting in an increase in the percentage of gas tubes beginning in November, 1945. Our data, thus far, do not indicate that we can operate at a fixed residual at this plant. A varying residual appears to be a natural consequence of variations in flow, chlorine demand, temperature, etc.

General Observations on Chlorination. We have found that, with our supplies, after a contact period of 10 minutes, best results are obtained if the flash residual and 5-minute residual agree. If the time


CHLORINATION OF WHITNEY SUPPLY
OF
NEW HAVEN WATER CO.
VARIATIONS IN AVERAGE CHLORINE DOSAGES AND RESIDUALS AND PERCENTAGES OF LACTOSE BEARING TUBES SHOWING GAS
1944
1945
FIG. 6

of contact is increased to an hour, the flash reading may be 85% of the 5-minute reading. These residuals have been checked with laboratory findings and the agreement has been close.

Chlorine-dosage rates that may give a residual of 0.2 to 0.5 ppm after ten minutes' contact may be in a range that produce very bad tastes and odors. At some of our small supplies, it was extremely difficult to operate the chlorinators at a rate where residuals would not fall into this range. After the introduction of free-residual chlorination, the chlorine-dosage rate was so much higher that the residuals were always above this critical range. Chlorinator operation has thus been made easier.

Our pumped supplies at the start of free-residual chlorination gave some very erratic residual and bacteriological results. Investigation indicated that the full chlorine-dosage rate must be applied instantly, when the pumps are started, and maintained until the pumps are shut down.

The variations in dosage rates during free-residual chlorination have been less for our large stored supplies than for the small ones. Lake Gaillard Supply has required a chlorine dosage varying from 0.8 to 1.3 ppm, while the smaller Lake Wintergreen Supply has required a chlorine dosage varying from 1.9 to 3.0 ppm. The filtered Lake Whitney Supply has been approximately the same as the Lake Gaillard Supply. In general, higher rates were required during the late summer and fall.

Microscopic Organisms. We have had several experiences showing the value of free-residual chlorination against tastes and odors due to microscopic organisms. In the winter of 1945-1946, when the reservoirs were covered with ice, *Asterionella* were present to the extent of 1,300 standard areal units per ml in the Lake Saltonstall Supply. Although this number produced a fishy odor in the untreated water, there was no evidence of it in the water in the distribution system.

Uroglena grew very rapidly in the Maltby No. 1 reservoir in March, 1946, and in a few days, before it was discovered, had reached a count of 10,000 standard areal units per ml, which amount produced only a very slight fishy odor in the water in the distribution system. This odor was not intensified upon copper sulphate treat-

ment. A heavy growth of *Dinobryon,* of 1,075 standard areal units per ml, in Prospect Lake over the week-end of June 16, 1946, did not cause any complaints, but a small operating difficulty with the chlorinator for part of a day, when chlorine-dosage rates were lower than the required amount for free-residual chlorination, caused a few complaints of a fishy taste and odor. The proper chlorine-dosage rate was re-established and the complaints quickly disappeared.

Tastes and Odors in the Distribution System. The change to free-residual chlorination was accomplished with few complaints of tastes, which included bitter, disagreeable and sweetish. Some of the supplies did not have any taste troubles, while others ran the gauntlet.

The odors encountered in all the supplies during the change to free-residual chlorination covered a greater variety than did tastes. Some of the odors noticed at certain times from different supplies were musty, grassy, woody, swimming-pool, sweetish, and chlorinous or pungent. Water, with free available-chlorine residual, flowing through the mains and services may acquire these tastes and odors, which, our experience indicates, may be of short duration, epecially if flushing is practiced. When free-residual chlorination had been used for some time, the tastes and odors disappeared, with the exception of chlorinous or pungent odor, which is sometimes noticeable in certain areas in the distribution system, when the water is first released from the pipes. The chlorinous or pungent odor disappears after the water has been standing a short time, exposed to the air. Our experience shows that, although consumers will question the cause of this, they are quite willing to accept it. A small area on a supply may have this odor but the general improvement is such that we feel justified in this method of treatment.

We have found that certain musty or woody odors may occur in the reservoir which will not respond to this treatment, although there may be some improvement. A free-residual chlorination test in the laboratory is necessary to determine the effect on such odors.

General Observations on Bacteriological Studies. All of our supplies satisfied the U.S.P.H.S. standards before the introduction of free-residual chlorination, but it is the policy of the New Haven Water Co. that, if possible, any process which would improve the supplies should be adopted. The improvement in the bacteriological

quality of our supplies by use of free-residual chlorination is shown in the following paragraphs.

Continuous application of free available-chlorine residuals has resulted, under various conditions, in a significant reduction of gas-forming organisms, so that less than 10% of the lactose tubes can reasonably be expected to show gas. It is also reasonable to expect a number of lactose tubes showing no growth and a reduction in the total count at 37° C.

The proportion of tubes showing gas in the presumptive test of the chlorinated water samples from all of our supplies was 43% in 1943, decreasing to 29% in 1944, with a further reduction to 11% in 1945 (2). Although the gas-producing organisms involved are usually non-confirming types in the bacteriological examination for the coliform group of bacteria, any process that tends toward their elimination provides an additional factor of safety and indicates a closer approach toward bacteriological purity.

Confirmed tests for the coliform group, made on samples collected from all of our supplies, showed the following results: in 1943, of 5,149 portions examined, 107, or 2.08%, were confirmed; in 1944, of 11,320 portions examined, 122, or 1.08%, were confirmed; in 1945, of 11,340 portions examined, 93, or 0.82%, were confirmed. These percentages reflect an improvement in the bacteriological quality of the waters as a result of free-residual chlorination.

An important consideration is the time of contact of the chlorine with the water. When the sampling point is near the chlorinator, the gas-producing organisms are less affected than when the sampling point is well within the distribution system. *Under the proper conditions of sampling, the presumptive test acquires greater value for control purposes, because of indications to warrant the view that the presence or absence of gas formers may be used as a guide in free-residual chlorination.*

Acknowledgments. We wish to acknowledge the cooperation of Edward E. Minor, Vice President of the New Haven Water Co., the assistance of employees of the New Haven Water Co. and the advice and criticism of A. E. Griffin, of the Wallace and Tiernan Co.

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Discussion

FREDERICK O. A. ALMQUIST (Hartford, Conn.). On your Lake Wintergreen Supply, how high was your chlorine residual and what was the pH value?

M. S. WELLINGTON. The pH was about 9.4. As far as the free available chlorine went, it is hard to tell with such a high pH.

F. O. A. ALMQUIST. What was the residual?

M. S. WELLINGTON. The residual was running around 1 ppm.

F. O. A. ALMQUIST. You could not eliminate the B. coli with that pH?

M. S. WELLINGTON. No, not with that pH.

LINN H. ENSLOW (New York, N. Y.). That confirms my experience early in the game,—so much so that in some water plants I had them put in active chlorination. That was before the days of metaphosphate, which Mr. Wellington is now using in place of lime to suppress the odors. That was the only way I could lick that problem at all. It was not a 100% answer then. It does seem as long as you add lime with chlorine you produce those undesirable mawkish tastes, so that I have always advised, when you are using lime, to keep it as far away from the chlorine as possible.

HAROLD W. GRISWOLD (Hartford, Conn.). But after the chlorine?

LINN H. ENSLOW. After the chlorine, as soon as you possibly can. You may have to resort to metaphosphates then, anyway.

I came in a little late and I did not hear all of the Wellington

paper, but there is one thing that impressed me in discussing this matter with him about a year ago and that is, with all of this work he has on hand and with the use of twice as much chlorine, if not more, it is costing the company very little more money, and the reason is that it threw him over into the classification of a one-ton-container user. That was the picture when I last talked to him, and if I am wrong, will you put me right, so that it will not be on the record wrong anyway?

M. S. WELLINGTON. I don't know just how much we are paying now for our chlorine gas—I don't know what the last price was that we got in March—so that I can't answer that. But I know it is not very much. If we could use one-ton containers, it would be all right but, with all these different places spread all over the land, we can't use one-ton containers.

F. O. A. ALMQUIST. You had some experience with flushing, didn't you? Would you care to say anything about that?

M. S. WELLINGTON. In some cases we had to flush and in some cases we did not. There is no rule on flushing. If you get bad water, you have to go out and flush; if you don't get bad water, you don't have to, and that is all there is to it. There is no hard and fast rule. In some places we flush and get very heavy silt out of the water; in other places we do not flush and it comes clean very fast.

LINN H. ENSLOW. The flushing has been rather successful, though?

M. S. WELLINGTON. Yes, it is a lot better since.

LINN H. ENSLOW. This chlorinous taste, that you say is sporadic and also limited to certain sections, more or less, and not universal—do you notice that more in cold water—cold-weather conditions?

M. S. WELLINGTON. No, it makes no difference whether the water is cold or warm. It doesn't make any difference whether you are putting in just enough chlorine for a free residual or whether you put in half again as much more. The odor is the same all the time.

CEMENT LININGS FOR CAST-IRON PIPE

BY THOMAS F. WOLFE*

[*Read September 20, 1946.*]

IN 1935 a committee of the New England Water Works Association investigated the matter of friction loss in pipe lines and prepared a report on that subject.† The report cited results of numerous friction-flow tests in various parts of the country. Most friction-flow tests are made because low pressures have been experienced and data necessary for improvements are needed. The result is that most reports cover cases where friction factors are low. In water systems where trouble has not been experienced, tests of this kind are very seldom made. The result is that any report based on published data of necessity includes a disproportionate number of cases where flow is impaired. Thousands of miles of pipe that had suffered no appreciable loss in carrying capacity, like the average individual who lives a normal life, never made the news.

I propose in this paper to tell you about some pipe lines that behaved themselves and consequently were never heard from, as well as to tell you the measures that may be taken to prevent trouble, where environment might in the normal course cause trouble.

For many years the Williams and Hazen formula has been used in loss-of-head calculations. The tests on which this formula was based indicated that new tar-dipped cast-iron pipe had a coefficient of 130 and that, as time went on, this fell off to less than one-half that amount. For design purposes it became the custom to use a value of "C" in this formula of 100. It just happens that most waters do not cause serious tuberculation and the practice of using a value of 100 gave results definitely on the safe side. Pipe lines designed on the basis of this value gave a performance above par—that is, either pumping costs were lower than contemplated or capacities exceeded those assumed in the original design.

On the other hand, there were cases where growths developed in

*Cast Iron Pipe Research Association, 122 So. Michigan Ave., Chicago, Ill.
†This Journal, 49:3, 235, Sept., 1935.

the pipe and flow was restricted to the point where higher pressures were needed at the pumping station, pipe cleaning became necessary or new lines were needed. Any of these procedures required an outlay of money and a remedy for the condition was desirable.

The first remedy for this trouble was suggested in about 1850, when the application of a tar dip to the pipe came into use. This dip was supposed to keep the water from actual contact with the iron and, in this fashion, prevent tuberculation. This pipe performed better than the older pipe which was laid uncoated. As time went on it became apparent that the tar coating was not continuous and, where active waters were handled, they managed to penetrate through the pin holes in the coating and tuberculation developed. The need for better methods of pipe lining became evident and cement-mortar linings were tried.

The first cement-lined pipes were made of thin-walled steel. A lining of natural cement mortar was applied by pouring the mortar around a form, centered in the steel shell. This lining solved the tuberculation problem but exterior corrosion soon destroyed the outer shell. The next step was to apply the cement mortar to both the interior and exterior surfaces of the pipe. This newer pipe gave great promise but difficulty was experienced in joint making and in the insertion of taps.

One of the water-works men who had used this latter type of pipe extensively then conceived the idea of lining cast-iron pipe. Such a pipe would have the usual bell-and-spigot joint and would have a wall thickness sufficient to hold taps.

This first cement-lined cast-iron pipe was made by setting the pipe vertically, inserting a projectile-shaped plug, having a diameter of about one-half inch less than the inside diameter of the pipe, and then pouring in sufficient mortar to line the pipe. The projectile was then withdrawn vertically and in this manner distributed and squeezed the mortar against the wall of the pipe. This method of lining gave excellent service but it had two major objections. It was difficult to control the lining thickness and it did not lend itself to quantity production.

The next improvement was to line the pipe centrifugally. This was done by mounting the pipe horizontally on rollers, inserting a

trough that contained the proper amount of mortar, revolving the pipe by power-driven rollers, spilling the contents of the trough, spreading the mortar by using the edge of the trough as a strike, and spinning at a high rate of speed. This method turned out good pipe but still did not permit mass production.

The final step was the development of the extrusion method of applying mortar lining through a hollow shaft. In this process the pipe is mounted on rollers as before. The hollow shaft is inserted to the far end of the pipe and mortar extruded as the shaft is withdrawn. Attached to the end of the shaft is a shoe, which trowels the surface of the mortar lining. With this method, sufficient mortar for lining a number of lengths can be prepared and placed in the hopper of the machine and lining can be placed at such a rate as to permit of mass production. After the pipes are lined, they are either stored in a moist atmosphere during the curing period or they are provided with a bituminous seal-coat, to prevent too rapid loss of moisture. The lining applied in this manner adheres to the wall of the pipe so closely that pipe may be cut and tapped without damage to lining.

Now let us examine the result of using lined pipe. In locations where experience had shown that a value of "C" as low as 70 would result after 10 years' service, the value remained over 130 after 15 years' service when lined pipe was used. The results of a number of tests on lined pipe are as follows:

Location	Size (in.)	Age (yr)	Coefficient
Concord, N. H.	12	11	145
Concord, N. H.	14	New	150
Watertown, N. Y.	10	14	150
Dedham, Mass.	8	10	142
Manchester, N. H.	12	5	142
Champaign, Ill.	16	13	140
Birmingham, Ala.	12	15	135
West Palm Beach, Fla.	12	15	142
Charleston, S. C.	12	15	145
Lincoln, Neb. (tar-coated)	36	12	132
Hammond, Ind. (tar-coated)	24	25	121
Chicago, Ill. (tar-coated)	30	30	136
Corpus Christi, Tex. (cement-lined)	30	7	146
Corpus Christi, Tex. (cement-lined)	36	New	145
Corpus Christi, Tex. (tar-coated)	20	29	102

Eight of the places indicated in the above table are in areas where tuberculating waters are handled. Unfortunately, we do not have results of tests of tar-dipped pipe in these same places. However, at Belmont, Mass., in the same general area, tests indicate that at the end of 10 years the coefficient for tar-dipped pipe had dropped to 70, after 20 years to 52, and after 30 years to 45. Old-style cement-lined pipe in the same town showed a coefficient of 121 after six years' use.

In the same table, the relatively high coefficients at Lincoln, Neb., Hammond, Ind., and Chicago, Ill., are indicative of what can be expected where non-active waters are handled. The tests at Corpus Christi, Tex., indicate clearly that the coefficient remains high when cement linings are used, in spite of the fact that the nature of the water was such as to reduce materially the coefficient in the tar-dipped line.

The significance of increased friction in pipe lines is evident in the following example. The table in this example shows the interest, sinking fund and pumping costs for five-year periods. It is to be noted that, at the end of about 23 years, these costs are less in 30-inch cement-lined pipe than they are in 36-inch tar-dipped pipe and from that time on the saving increases with each year of age. In the case of smaller pipe in distribution systems, pipe size is ordinarily determined by fire demand and actual saving in pumping costs may not be significant. On the other hand, during an emergency the carrying capacity of the cement-lined pipe may be what stops a fire in its early stages.

From the standpoint of effect on tastes, odors and red water, the problem is more complicated than is the case where pumping economies alone are concerned. Waters having certain characteristics may develop any or all of these difficulties, regardless of the type of pipe used. On the other hand, in those cases where picking up iron from the pipe causes the trouble, cement linings are bound to eliminate the difficulty.

To sum up:

1. Cement linings after an eighty-year history indicate that they will prevent tuberculation.

2. In supply lines, the high "C" values that result from the use of cement linings result in economy due to lower pumping costs.
3. The use of cement linings may make it possible to use smaller-diameter pipe, since the flow coefficient remains constant, as compared to a reduced capacity where ordinary pipe is used.
4. With certain types of water cement lining mitigates tastes, odors and red-water troubles.
5. Modern cement linings adhere to the wall of the pipe and are not injured by cutting or tapping.

EXAMPLE OF EFFECT OF USING CEMENT-LINED PIPE ON PUMPING COSTS

Assumptions: Water demand new, 12 mgd
Water demand 30 years later, 16 mgd
Length of line, 20,000 ft
Delivery pressure, 100 ft
Cost of pumping 1,000,000 gallons 1 ft high—$.05
Cost of 30-in. cement-lined pipe—$9.80
Cost of 36-in. tar-dipped pipe—$11.80
Interest, 4%
Coefficient of cement-lined pipe—140
Coefficient of tar-dipped pipe—130, falling off as in Williams and Hazen Tables

Period (yr)	Demand (mgd)	C	Loss per 1,000 ft (feet)	Total head on pump (feet)	Million foot-gallons	Power cost per day	Interest & S.F. per day	Power plus int. & S.F. per day	Pumping cost for 5-yr period	Cumulative pumping cost
					36-inch Tar-dipped					
0-5	12.33	126	0.68	114	1410	$ 70.50	$26.40	$ 96.90	$176,500	$ 176,500
5-10	13.00	118	0.84	117	1520	76.00	26.40	102.40	187,000	363,500
10-15	13.67	109	1.06	121	1650	82.50	26.40	108.90	198,500	562,000
15-20	14.33	103	1.28	126	1810	90.50	26.40	116.90	213,200	775,200
20-25	15.00	97	1.57	131	1960	98.00	26.40	124.40	227,000	1,002,200
25-30	15.67	92	1.90	138	2160	108.00	26.40	134.40	245,500	1,247,700
30-35	16.00	88	2.14	143	2290	113.50	26.40	139.90	255,000	1,502,700
35-40	16.00	84	2.32	146	2340	117.00	26.40	143.40	262,000	1,764,700
40-45	16.00	81	2.48	150	2400	120.00	26.40	146.40	268,000	2,032,700
					30-inch Cement-lined					
0-5	12.33	140	1.35	127	1570	$ 78.50	$21.90	$100.40	$183,300	$ 183,300
5-10	13.00	140	1.48	130	1690	84.50	21.90	106.40	194,000	377,300
10-15	13.67	140	1.64	133	1830	91.50	21.90	113.40	207,200	584,500
15-20	14.33	140	1.78	136	1950	97.50	21.90	119.40	218,000	802,500
20-25	15.00	140	1.95	139	2080	104.00	21.90	125.90	229,500	1,032,000
25-30	15.67	140	2.10	142	2220	110.00	21.90	131.90	240,600	1,272,600
30-35	16.00	140	2.19	144	2300	115.00	21.90	136.90	250,000	1,522,600
35-40	16.00	140	2.19	144	2300	115.00	21.90	136.90	250,000	1,772,600
40-45	16.00	140	2.19	144	2300	115.00	21.90	136.90	250,000	2,022,600

PROCEEDINGS

Sixty-fifth Annual Meeting

Poland Spring, Maine

September 17 to 20, 1946

The Sixty-fifth Annual Meeting of the New England Water Works Association was held at the Poland Spring House, Poland Spring, Maine, September 17 to 20, 1946.

September 17, 1946

Morning Session

President Harold W. Griswold in the Chair.

The Annual Reports of the Secretary, Treasurer, Editor, Committee on Library, Committee on Membership, Finance Committee, Committee on Legislation, Committee on Committees and Committee on Reciprocal Relations with the Institution of Water Engineers (England) were presented, accepted and ordered placed on file.

The following progress reports of technical committees were presented and accepted: Committee on Gate Valves, Hydrant Specification Committee, Committee on Laying Cast-Iron Pipe, Committee on Sluice Gates, Committee on Specifications for Cast-Iron Pipe and Special Castings and Committee on Technical Specifications from Joint Committees.

Informal reports were presented by the Committee on Cathodic Protection of Steel Tanks and Standpipes, the Committee on Classification of Water Works Employees and Salaries, the Committee on Reinforced Concrete Pressure Pipes and the Committee on Threads for Underground Service Lines. All formal reports are printed in this issue of the Journal.

On motion of Roger W. Esty, duly seconded, it was Voted that the Hydrant Specification Committee be continued.

The President declared the polls closed and appointed as tellers Roger G. Oakman, Frank J. Callahan and Charles G. Richardson.

There was considerable discussion on a motion by Roger W. Esty that the New England Water Works Association appoint a committee of at least five to take up the desirability of forming a North American Water Works Association by the union of the New England Water Works Association and the American Water Works Association, discuss it with the members of the Association and, perhaps, try to get a report in not later than the next annual convention. Upon motion of David E. Moulton, duly seconded, it was VOTED that the matter be postponed indefinitely.

Secretary Conroy announced the following elections to membership in the Association:

John L. Bean, Asst. Supt., Water Dept., Ayer, Mass.; Francis T. Bergin, Asst. Sanitary Engr., Metropolitan District Water Supply Commission, Waltham, Mass.; Abner C. Bristol, Div. Mgr., Northern Division, Connecticut Light & Power Co., Thompsonville, Conn.; Charles J. Christy, Engineer, The Pitometer Co., New York, N. Y.; Gerald H. Davis, Div. Engr., Connecticut Light & Power Co., Enfield, Conn.; Walter A. Goss, Asst. Supt., Water & Light Dept., Littleton, N. H.; Richard Hazen, Partner, Malcolm Pirnie Engineers, New York, N. Y.; Waldo I. Kenerson, Vice-Pres., Burns & Kenerson, Engineers, Boston, Mass.; Herbert D. Morrison, Mgr., Water Company, Jewett City, Conn.; Elbert R. Sherman, Asst. Engr., Connecticut Light & Power Co., Thompsonville, Conn.

Junior: Hugo Perez-La Salvia, Sanitary Engineer, Caracas, Venezuela.

Associate: Clayton Mfg. Co., Providence, R. I.; Pittsburgh Pipe Cleaner Co., New York, N. Y.; H. R. Prescott & Sons, Worcester, Mass.

Luncheon Session

AWARD OF THE DEXTER BRACKETT MEMORIAL MEDAL

PRESIDENT GRISWOLD. The feature of this luncheon meeting is the presentation of the Dexter Brackett Memorial Medal. This was established in 1916 to honor Dexter Brackett, a very eminent water works engineer, for many years connected with the Metropolitan District Supply of Boston. The rules provide that annually the

Executive Committee shall appoint a committee of three members who shall select the most meritorious paper written by a member and published in the JOURNAL during the preceding year. The committee for this year consisted of George A. Sampson, Chairman, Charles B. Hardy and F. Wellington Gilcreas. It is a pleasure to ask Mr. Sampson to present the medal this year.

GEORGE A. SAMPSON. Mr. President and members of the New England Water Works Association, members of the Water and Sewage Works Manufacturers Association and guests:

Your President has taken a good deal of the thunder out of my mouth but I will try to carry on from there. He has told you about the purposes of the medal.

This is the thirty-first annual award, it being established in 1916. If any of you have served on this committee you will appreciate how many excellent papers are published in the JOURNAL each year. It was with some difficulty, therefore, that we finally selected unanimously the paper entitled "Pre-stressed Reinforced Concrete Pipe" as most worthy of the award. Confidentially, we had some misgivings about this award, because the name of a prominent manufacturer of concrete pipe appeared in print on fourteen different occasions, and that is against the rules, you know, of this association; but, in spite of this handicap, we recommended to the Executive Committee that the award be made for this paper.

Now, it so happens that the paper was presented and written, so I am reliably informed, by the author—by Francis F. Longley. Mr. Longley became a member of this association in 1906 and has contributed many modern papers to the association. He is an eminent engineer, was a colonel in the famous 26th Engineers, the water-supply regiment that served with distinction overseas from August, 1917, to 1919.

Soon after the war Mr. Longley became associated with the company which appeared by name so many times in the article—I will not mention the name—and since then he has developed a reinforced concrete pipe for carrying water, and I am sure that when further improvements are made Mr. Longley will be right up there in the front ranks.

Mr. Longley, it gives me great pleasure, in behalf of the New

England Water Works Association, to present you with this Dexter Brackett Memorial Medal.

FRANCIS F. LONGLEY. I must stop and look at it a moment.

Mr. President, ladies and gentlemen, I must say that I am quite overwhelmed by this honor. I suppose you have all seen this medal from time to time, and I shall be very glad to let you see it closer if you would like to. I want to thank the New England Water Works Association and also the Committee of Award for doing what they have done in awarding this medal to me.

This morning I met our genial President and asked him whether I was supposed to respond in any way to this gift, and he said, "How should I know? I don't know what to do myself. At any rate, don't make it too long." I am not going to make it too long, but the receipt of a medal of this sort presupposes that there is something in this paper that is really scientific.

Well, every now and then, in the privacy of my family, we have conversations that border on the scientific. My good wife here will vouch for that. She is always a very interested spectator, and you should hear the part she takes in the scientific discussion. Not very long ago an incident occurred in the house that I am going to take a few minutes to tell you about. Somebody read something that had a scientific basis, and I want to read some paragraphs from it. It goes as follows [reading extremely technical article]. When that was passed around in our family circle, one of my sons said to me, "Dad, that is nothing but a lot of nonsense." "Well," I said to him, "be that as it may, you must not set this aside, you must take it seriously." I said to him, "About a year ago I wrote a paper for that fine, august, ancient organization they call the New England Water Works Association, and they assigned a group of three high-brow engineers to examine the papers and look them over, and my paper, which sounded in part exactly like the thing I have just read to you, was awarded a medal, if you please."

Well, ladies and gentlemen, nonsense aside, I do feel immensely tickled, gratified in every sense of the word, at being the recipient of this medal. I was present when Mr. Saville received the first award of this medal, which, as Mr. Sampson said, was thirty-one

years ago. At that time I looked with the utmost interest on him as an eminent engineer who could write such a paper.

I had some second-hand acquaintance with Mr. Dexter Brackett, through his old acquaintanceship with engineers whom I later knew, who were then much older than I. But I was very much impressed with the whole idea of a medal commemorating the service to the public which Mr. Dexter Brackett had carried out so effectively over a long term of years, and whose principles of water-works engineering find expression so often in the water-works treatises.

I want to say once again that I thank the Association for the honor more than I can tell.

Afternoon Session

A paper "Additions to Springfield's Transmission Mains" was read by Peter C. Karalekas, Chief Water Engineer, Springfield, Mass.

A paper "Problems in Disposal of Sludge and Wash Water for Connecticut Water Filtration Plants" was read by Frederick O. A. Almquist, Principal Sanitary Engineer, State Department of Health, Hartford, Conn.

A paper "Free-Residual Chlorination at the New Haven Water Company" was read by Marshall S. Wellington, Sanitary Engineer, New Haven Water Co., New Haven, Conn.

Evening

Through the courtesy of the Water and Sewage Works Manufacturers Association, Inc., dancing and an entertainment were enjoyed at the Poland Spring House.

September 18, 1946

There were no technical sessions on this day. A Men's Golf Tournament was run. In the evening a Costume Party, with dancing and entertainment, was given at the Poland Spring House, by courtesy of the Water and Sewage Works Manufacturers Association, Inc.

Prizes for the various events were won by the following:

GOLF

Low Gross

Active Members—R. E. Murphy
Assoc. Members—Winthrop Hersey

Kickers

Active Members—Gerald Bolton
James V. Turner
Peter Karalekas
J. J. Sampson
Assoc. Members—Ray Parkhurst
H. H. Draper

Putting

Ladies—Mrs. Karl M. Mann
Men —Julian McKenzie

COSTUME PARTY

Ladies—Mrs. Edward Rothman
Men —Donald Calderwood

September 19, 1946

Morning Session

President Harold W. Griswold in the Chair.

The President called attention to a Federal regulation which had just been issued—namely, National Housing Agency Regulation HEPR—2.

A paper "Toronto Water Works Extensions" was read by William Storrie, Consulting Engineer, Gore & Storrie, Toronto, Ontario.

A paper "Reforestation on the Quabbin Reservoir Project" was read by Russell Snow, Forester, Metropolitan District Water Supply Commission, Boston, Mass.

A group of papers on "Problems and Progress in Handling Stream Pollution Abatement in New England" was read by representatives of the six New England states: Warren J. Scott, Director, Bureau of Sanitary Engineering, State Department of Health, Connecticut; J. Elliott Hale, Technical Secretary, State Sanitary Water Board, Maine; Leonard W. Trager, Technical Secretary, Water Pol-

lution Board, New Hampshire; Edward L. Tracy, Director, Division of Sanitary Engineering, Department of Public Health, Vermont; Walter J. Shea, Acting Chief, Division of Sanitary Engineering, Department of Health, Rhode Island, and Arthur D. Weston, Director, Division of Sanitary Engineering, Department of Public Health, Massachusetts.

Upon motion of Thomas R. Camp, duly seconded, it was VOTED that the Executive Committee appoint a representative to foster the formation of, and become a member of, a joint committee representing the various societies and associations interested in stream pollution abatement, which committee shall draft a suitable bill for Federal participation in stream pollution abatement, get it introduced into Congress and promote its passage into law.

Afternoon Session

A motion picture, "Clean Waters", was shown through the courtesy of the General Electric Co.

A paper "Corrosiveness of Water to Metals—Part II. Practical Application of the Theory" was read by Thomas R. Camp, Consulting Engineer, Boston, Mass.

A paper "Okinawa Water Treatment Plants" was read by E. W. Campbell, Director, Division of Sanitary Engineering, State Department of Health and Welfare, Augusta, Me.

A motion picture, "Concrete Facts," was shown through the courtesy of the Master Builders Co., Cleveland, O., and a motion picture, "Installing Cast Iron Pipe," was shown through the courtesy of the Cast Iron Pipe Research Association, Chicago, Ill.

Evening

Through the courtesy of the Water and Sewage Works Manufacturers Association, Inc., a dinner and entertainment were given in the main dining room of the Poland Spring House.

William J. Orchard, acting as Master of Ceremonies, introduced President Harold W. Griswold, who spoke briefly. Mr. Griswold then introduced Frank E. Southard, Chairman, Maine Public Utilities Commission, who gave an address of welcome to the Association. Mr.

Griswold also introduced Wendell R. LaDue, President of the American Water Works Association, who gave a brief address.

September 20, 1946

Morning Session

Allen M. Symonds in the Chair.

A paper "Cement Linings for Cast-Iron Pipe", prepared by Thomas F. Wolfe, was read by H. Lloyd Nelson.

A Superintendents' Round Table was held, during which the following subjects were discussed:

(1) The cost of installation of water mains in private ways and new developments shall be at the expense of the developer.

(2) Due to the heavy draft on water-supply systems this summer, were any steps taken by your department to protect the water supply and pressures of your distribution system from being depleted?

Upon motion of Roger G. Oakman, duly seconded, it was VOTED that a committee be appointed for the purpose of investigating and reporting on the factors that should be considered by a municipally-owned and -operated water department, and by a privately-owned and -operated water system, in setting up what would be the charge which should be made for the extension of water mains into undeveloped territory, on the basis of making such charges sufficient to meet the annual charges on the cost of such an extension.

President H. W. Griswold in the Chair.

Certificates were awarded to the following Superintendents who have completed 25 years of membership in the Association as well as 25 years of service in their towns and cities: Dennis P. Sullivan, Malden, Mass.; James E. Gibson, Charleston, S. C.; W. Guy Classon, Leominster, Mass.; Henry F. Hughes, Medford, Mass.; Charles F. Notsley, Williamstown, Mass.; Roger W. Esty, Danvers, Mass.; Samuel D. Soule, Gardiner, Me.

The President announced that Joe Lufkin was attending his fifty-fifth consecutive convention of the Association. Mr. Lufkin received the applause and congratulations of all present.

REPORT OF TELLERS OF ELECTION

Total ballots cast	281
For PRESIDENT, Arthur L. Shaw	276
For VICE-PRESIDENT, Arthur C. King	277
For DIRECTOR, Philip J. Holton, Jr.	274
For TREASURER, William P. Melley	277

(*Signed*) F. J. CALLAHAN
C. G. RICHARDSON
R. G. OAKMAN

THE PRESIDENT. The report of the tellers is accepted and you have elected the officers whose names have been read.

ADDRESS BY THE RETIRING PRESIDENT, HAROLD W. GRISWOLD

A full year has elapsed since our country turned from active warfare toward the ways of peace. It has been a year of turmoil, of clashing ideas and ideals, both on the domestic and international fronts, and the vision of a brave new world which seemed so close and so sure on V-J Day is neither so near nor so certain now. Reaction from the strain and tension of war has brought into prominence many ugly aspects of our national life—brawls between labor and management, unfaithfulness in high places, and plain greed, selfishness and irresponsibility in all walks of life. If the pattern of the aftermath of World War I repeats, this is a passing phase—a swinging of the pendulum—and the brave new world is not utterly lost, merely postponed awhile.

As befits a stable and conservative industry, our water works have come through the last year remarkably well—without either heroics or hysterics. The job of furnishing war industries with sufficient water, while still carrying the domestic load, has tapered off a bit, and wartime restrictions on inventories and on the use of labor and material for maintenance and new installation have been lifted, but these have been replaced in large measure by the pressing need for immediate rehabilitation of water-works facilities of all kinds and for obtaining material and labor for extensions, to serve the new homes which must be built at the earliest possible moment to house the post-war generation.

Most of those of the water-works fraternity who served in the armed forces are civilians again, and of these it is gratifying to observe that the majority have returned to their former jobs, where they have been warmly welcomed. They are better men than when they were called to service—more experienced, more mature—and presently they will find themselves at more skilled and more important tasks than those they left. This Association welcomes back all its members returning from service and assures them that it stands ready to serve them to the limit of its ability in any way that it can. In return, it seeks their support and asks that the water-works experiences and knowledge, which they have gained through service in all the countries of the world, be shared by means of papers and discussions at our meetings. For those who did not return and never can return, we mourn, and we offer our deepest sympathy to those who were near and dear to them.

Industry has used this reconversion period as a time for taking stock and making plans for the future, and I believe this Association could well do likewise at this time.

Growth of our Association, as reflected by increase in membership, continues, but at a slow rate. Your Membership Committee, under the Chairmanship of Francis Kingsbury, proposes to remedy this by an intensive canvass of all non-member water utilities in New England. This needs the backing and help of every member of the Association.

Meetings have been well attended and the Committee on Technical Programs, under the Chairmanship of Stanley Dore, has arranged interesting and instructive programs. The Water Works School, under the able leadership of Professor Russell, has continued its popularity, and the Superintendents' Round Table discussions and the meetings of the Chemists have been a feature of each regular meeting. I have a feeling that occasional joint meetings of these two groups for discussions of management and labor problems would be advantageous. The practice of having a Northern New England meeting, a Southern New England meeting, and a June outing was resumed, and your Convention here has followed the pattern of former years, except for a different—and perhaps a better—arrangement of exhibits. Our hearty thanks are due to the Manufacturers Association

for the very fine entertainment and instructive exhibits they have provided at this Convention and for the support and help they have given the Association and its Technical Committees throughout the year.

Early in the year the office of Secretary became vacant, due to the death of Frank J. Gifford, a member since 1907 and our Secretary since 1920. Until a successor could be appointed, your President-elect, Arthur Shaw, carried on the Secretary's work and the Association's thanks are due to him for this service. Walter C. Conroy, Superintendent at Belmont, became Secretary in November and he, together with his capable assistant, Mrs. Melrose, not only has handled the routine work of the office most efficiently but has modernized office routine and records.

The practice of making separate appointments for Secretary and Treasurer was resumed by the appointment of William P. Melley as Treasurer.

Professor Gordon Fair, Editor of our JOURNAL since June, 1927, asked to be relieved of the editorship after the publication of the September, 1945, issue. This was reluctantly agreed to and the burden of publishing Volume 60 was laid on the capable shoulders of George Houser. Thanks and much appreciation are due to Professor Fair from this Association for his nearly twenty years of capable and conscientious service as Editor.

Some of our Technical Committees continued to function in a restricted way all during the war, although most found it imperative to suspend their activities. It is hoped that during the coming year all will resume work and that the progress made in all science under the forced draft of war will be a challenge to these Committees so to carry on their work that those new discoveries in materials and processes useful in the water works field may be made available without undue delay to the membership of the Association. I suggest that it would be of benefit to require reports from many of these Committees oftener than once a year, and also that it would be helpful to have committee coverage in those parts of the legal field and of the labor-relations field with which the water-works operative is commonly in contact.

Financially the Association's position is satisfactory. Rising costs

have made it necessary to increase advertising rates in our JOURNAL and for your Finance Committee to recommend an unbalanced budget for 1947. There is sufficient surplus to operate in the red for a couple of years, until our expenses become stabilized again, but over the long term a balanced budget is imperative to sound operation of an Association such as ours.

As my term as President draws to a close, I become more and more grateful for the help I have had from the Executive Committee, from the Secretary's Office, from the Treasurer, and from the Editor, the Committees and the Manufacturers Association. Their team work and friendly cooperation have made my year as President a very happy one.

I thank most heartily, also, those who have participated in our meetings, contributed papers to our JOURNAL, served on our Committees, or in other ways helped the Association carry on its work during the past year.

It is now my pleasure and privilege formally to introduce to you your next President, Arthur L. Shaw, of Metcalf & Eddy, Boston. I shall turn the meeting over to Mr. Shaw.

ARTHUR L. SHAW. Thank you, Mr. ex-President, and fellow members and ladies. You have just elected me to your highest office. For the past five years you have entrusted me with a share in the management of this organization, and I shall have to draw very heavily upon that experience in order to follow adequately in the footsteps of my immediate predecessor and those many illustrious men who form the list of our former Presidents. In accepting this office and in thanking you for the confidence which it implies, I want to remind you that I shall depend very heavily upon the cooperation of every member of the Association.

We have had a very successful convention, which is now drawing to a close, and I think I shall release you to enjoy those closing moments rather than to require you to listen further to any words which I might speak. I therefore declare the Sixty-fifth Annual Meeting of the New England Water Works Association formally closed.

ANNUAL REPORT OF THE SECRETARY

Mr. President and Gentlemen of the New England Water Works Association: The Secretary herewith submits the following report of the changes of membership during the past fiscal year and the general condition of the Association.

The present membership is 826, constituted as follows: 11 Honorary Members, 676 Members, 1 Junior Member, 110 Associate Members and 28 Corporate Members.

MEMBERSHIP

				Total
September 1, 1945—Honorary Members, Total		11		
Withdrawals		0		
Elected		0		11
September 1, 1945—Members, Total		657		
Withdrawals:				
Resigned	15			
Died	11			
Dropped by Executive Committee	16	42	615	
Elected:				
September 11, 1945	3			
October 4, 1945	3			
November 1 and 15, 1945	6			
December 20, 1945	7			
January 10, 1946	1			
February 28, 1946	8			
March 21, 1946	14			
April 18, 1946	13			
May 16, 1946	6		61	676
September 1, 1945—Juniors, Total		1		
Withdrawals	0			
Elected	0	0		1

September 1, 1945—Associates, Total		116		
Withdrawals:				
Resigned		9	107	
Elected:				
February 28, 1946	1			
March 21, 1946	1			
May 16, 1946	1		3	110
September 1, 1945—Corporates, Total		28		
Withdrawals	0			
Elected	0	0		28
September 1, 1946—Total Membership				826
September 1, 1945—Total Membership				813
Net Gain				13

ELECTIONS

Members

September 11, 1945—Kenneth E. Shull, Raymond T. Wendell and George W. Wood. (3)

October 4, 1945—James F. Folsom, Albert H. Justin and Myron E. Sprague. (3)

November 1, 1945—Albert S. Genaske, Julian L. McKenzie, Marvin C. Nichols and W. Frederick Spence. (4)

November 15, 1945—Walter M. Campbell and Sherman L. Rogers. (2)

December 20, 1945—Philip E. Bond (Reinstated), E. Shaw Cole, G. Arthur Faneuf, Clifton E. Hodgdon, Alfred A. Osterman, Clyde B. Rowntree and Jerome L. Spurr. (7)

January 10, 1946—Ernest J. Fenn. (1)

February 28, 1946—Asa H. Copeland, Harry P. Danaher, Charles J. Knoener, James P. McCarthy, Paul M. Nickerson, George N. Watson, Angelo Iantosca and Victor Jansa. (8)

March 21, 1946—Frank C. Barrows, C. Hugo Bergman, Columbus G. Carley, Clarence K. Dion, Edwin S. Evans, Peter C. Karalekas, Harry W. Kendrick, Arthur M. Lawton, Emery S. Littlefield, Jr., Charles B. Perkins, Edmund C. Sanderson (Reinstated), James F. Shurtleff, Donald B. Stevens and Gordon C. Tower. (14)

April 18, 1946—John J. Campobasso, Richard M. Cleveland, Henry J. DiMestico, William G. Dyer, Justin A. Holden, Vail O. Leach, Frederick F. Libby, William L. Morse, Clair N. Sawyer, Ariel A. Thomas, Harold C. White, Philip L. White and Dr. J. R. Hurtado. (13)

May 16, 1946—William F. Ablondi, Nathan C. Avery, Joseph H. DeFoe, Wilpas V. Kallio, Frank O'Connell and Russell J. Rice. (6)

Associate Members

February 28, 1946—R. E. Chapman Company. (1)
March 21, 1946—Utilities Supply Corporation. (1)
May 16, 1946—Moore and Company. (1)

WITHDRAWALS

Members

Resigned: Edwin H. Arnold, Chester E. Bradley, W. P. Brereton, Fred E. Ellis, Henry W. Estey, Ernest Goobie, Otto Hagmann, James C. Harding, Alfred A. Lamarine, John C. Moore, Peter S. Sinclair, Donald E. Stearns, James B. Swaim, Walo VonGreyerz and Dana M. Wood. (15)

Died: William R. Conard, James H. Dillon, Frank J. Gifford, Thomas G. Hazard, Robert E. Horton, J. Frederick Jackson, Edward F. Jerome, W. A. MacKenzie, J. J. Moore, Arthur V. Ruggles and Arthur N. Burnie. (11)

Dropped by Executive Committee: Richard P. Barstow, William H. Boardman, Winthrop C. Butts, Walter H. Chase, Carl A. Clark, Manfredi de Horatiis, Leonard Domingue, Thomas C. Flinn, Donald W. Foster, John T. Ford, Irving S. Hazard, Henry Ibbotson, Jr., Charles E. Lane, Otto J. Meotti, Charles A. Mixer and Humphrey Sullivan. (16)

Associate Members

Resigned: Ampco Metals, Inc., Cambridge Machine & Valve, Inc., Dixon Crucible Company, Donaldson Iron Company, Ferguson & Pascoe, James A. Munroe & Sons, Nukem Products Corporation, Royer Foundry & Machine Company and The Ruberoid Company. (9)

RECEIPTS FOR THE FISCAL YEAR SEPTEMBER 1, 1945, TO SEPTEMBER 1, 1946

Entrance Fees	$ 206.00
Dues of All Grades of Members	5,992.50
Dividends	393.52
Advertisements	3,429.00
Subscriptions	612.20
Journals	155.22
Reprints	13.00
Half-tones, etc.	5.99
Membership Certificates	39.00
Sundries	3.18
Total Receipts	$10,849.61

There is due the Association:		
Dues	$19.50	
Entrance Fees	3.00	
Advertisements	89.00	
Subscriptions	20.00	131.50
Total		$10,981.11

Respectfully submitted,

(*Signed*) WALTER C. CONROY, *Secretary*

ANNUAL REPORT OF THE TREASURER

Boston, September 9, 1946

To William P. Melley, Treasurer,
New England Water Works Association,
Boston, Massachusetts

We have examined the statement of assets and funds and the statement of cash receipts and disbursements of the general fund of the New England Water Works Association for the fiscal year ended August 31, 1946. In connection therewith we have reviewed the accounting procedures of the association and have examined accounting records of the association and other supporting evidence, by methods and to the extent we deemed appropriate.

We traced all recorded receipts into the depositary bank, verified the general fund bank account and petty cash fund as at August 31, 1946, and examined properly approved vouchers for all disbursements. We also verified by direct communication the investment funds on deposit in savings banks, and on September 4, 1946, we examined the United States War Savings Bonds at the Second National Bank of Boston.

In our opinion, the accompanying statement of assets and funds and the note thereon and the related general fund cash statement present fairly the position of the New England Water Works Association at August 31, 1946, and the recorded cash receipts and disbursements for the fiscal year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(*Signed*) SCOVELL, WELLINGTON & COMPANY

STATEMENT OF ASSETS AND FUNDS (EXHIBIT A)

As at August 31, 1946

Assets

Cash in Banks, Invested Funds		
Farmers and Mechanics Savings Bank, Framingham, Massachusetts	$ 1,068.46	
Franklin Savings Bank, Boston, Massachusetts	1,000.00	
Haverhill Savings Bank, Haverhill, Massachusetts	1,000.00	
Home Savings Bank, Boston, Massachusetts	1,000.00	
Mechanics Savings Bank, Reading, Massachusetts	1,000.00	
Pentucket Savings Bank, Haverhill, Massachusetts	1,000.00	
The People's Savings Bank, Worcester, Massachusetts	1,000.00	
Suffolk Savings Bank, Boston, Massachusetts	1,000.00	$ 8,068.46
Securities		
United States War Savings Bonds G 2½s, 1954	10,000.00	
25 shares Milton Co-operative Bank, Series of June, 1940	2,111.75	12,111.75
Total Invested Cash and Securities		20,180.21
General Fund		
Cash, Second National Bank of Boston	4,577.22	
In Office	50.00	
	4,627.22	
Furniture and Fixtures	1,180.00	5,807.22
		$25,987.43

Funds

Invested Funds		$20,180.21
General Fund		
Balance, August 31, 1945	$ 7,343.62	
Deduct Purchase of Milton Co-operative Bank Shares	2,099.25	
	5,244.37	

Add Excess of Receipts over Disbursements, Exhibit B	562.85	
Balance, August 31, 1946		5,807.22
		$25,987.43

Note: The statement above, prepared on a cash basis, includes dues received in advance, $2,373.00, and employees' withholding tax, $114.10. It does not reflect the following:

Accounts Receivable, Dues and Initiation Fees	$ 22.50
Due on Account of Advertising and Subscriptions	109.00
	$ 131.50

No depreciation has been taken on Furniture and Fixtures.

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS (EXHIBIT B)

General Fund

For the Year Ended August 31, 1946

Receipts (exclusive of dues received in advance and employees' withholding tax)			
Initiation Fees		$ 206.00	
Dues, 1945-1946 and Prior Years		3,619.50	
Interest		393.52	
From Publication of Journal			
Advertisements	$3,429.00		
Subscriptions	612.20		
Sale of Journal	155.22		
Sale of Reprints	13.00		
Sale of Halftones, Electros, etc.	5.99	4,215.41	
Miscellaneous			
Membership Certificates	39.00		
Sundry	3.18	42.18	
Total Receipts			$ 8,476.61
Disbursements			
Publication of Journal			
Printing	$2,866.30		
Plates	364.77		
Reporting	156.92		
Reprints	30.00		

Stationery and Postage	75.86		
Editor's Salary	500.00		
Sundry	59.23	4,053.08	
Office and General			
Certificates of Membership	25.35		
Secretary's Salary	300.00		
Assistant to Secretary—Salary	1,717.50		
Treasurer's Salary	100.00		
Employee's Bonds	50.00		
Printing, Postage and Stationery	720.87		
Office Supplies and Expense	500.52		
Office Rent	1,200.00		
Electricity	82.44		
Telephone and Telegraph	176.65		
Auditing	65.00		
Social Security Taxes	117.30		
Sundry	69.95	5,125.58	
Meetings and Committees			
Water Works School	125.00		
Printing, Postage and Stationery	737.95		
Convention Expense	108.01		
Sundry Expense	238.74	1,209.70	
Interest Added to Co-operative Bank Shares		12.50	
Total Disbursements			$10,400.86
Excess of Disbursements over Receipts (exclusive of dues received in advance and employees' withholding tax)			1,924.25
Dues Received in Advance		2,373.00	
Employees' Withholding Tax		114.10	2,487.10
Excess of Receipts over Disbursements, Exhibit A			562.85
Balance, General Cash, August 31, 1945		6,163.62	
Less Purchase of Milton Co-operative Bank Shares		2,099.25	4,064.37
Balance, General Cash, August 31, 1946 Represented by			
Cash in Second National Bank of Boston		4,577.22	
Cash in Office		50.00	
			$ 4,627.22

ANNUAL REPORT OF THE EDITOR

To the New England Water Works Association:

The Editor submits herewith his report for the year ending August 31, 1946.

As has been customary in the past, the tables of financial figures, accompanying the report, are based upon total charges and accounts receivable, rather than actual cash received and disbursed. A detailed statement of the receipts and disbursements on account of the September and December, 1945, and March and June, 1946, issues of the JOURNAL is included in the report of the Treasurer.

In Table 1 is presented a statement of the material contained in the four issues of the JOURNAL for the past year, while in Table 2 is given a comparison of the JOURNAL for the past year with those for preceding years.

TABLE 1.—STATEMENT OF MATERIAL IN SEPTEMBER AND DECEMBER, 1945, AND MARCH AND JUNE, 1946, ISSUES OF THE JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

	Papers	Proceedings	Total text	Index	Advertisements	Cover and contents	Insert plates	Total pages	Total cuts
Sept., 1945	48	40	88	0	42	4	0	134	22
Dec., 1945	39	44	83	8	42	4	0	137	9
Mar., 1946	98	12	110	0	42	4	1	157	11
June, 1946	106	4	110	0	44	4	0	158	9
Total	291	100	391	8	170	16	1	586	51

Size. The four issues contained 586 pages, of which 391 were text.

Cost. The gross cost of the JOURNAL was $4,053.08, equivalent to $4.94 per member; the net profit was $162.33, equivalent to $0.20 per member.

Reprints. Reprints of papers have been furnished to authors at cost.

TABLE 2.—COMPARISON OF JOURNALS OF THE NEW ENGLAND WATER WORKS ASSOCIATION.
Four Issues for Fiscal Year Ending August 31

	1937	1938	1939	1940	1941*	1942‡	1943**	1944	1945	1946
Average edition (copies printed)	1,100	1,100	1,100	1,100	1,100	1,100	1,175	1,200	1,200	1,200
Average membership	772	785	795	796	800	803	798	799	806	820
Circulation at end of year	920	943	946	967	943	982	969	1,015	1,032	1,042
Pages of text	423	510	488	565	540	575	442	442	438	391
Pages of text per 1,000 members	561	650	614	710	675	716	554	553	543	477
Total pages, all kinds	627	699	670	762	733	757	616	621	630	586
Total pages per 1,000 members	812	890	843	957	918	943	772	777	782	715
GROSS COST:										
Total	$5,040.86	$4,658.05	$4,119.30	$3,846.46	$4,415.00	$4,053.47	$4,234.68	$3,406.48	$3,734.19	$4,053.08
Per copy	1.23	1.06	0.94	0.87	1.00	0.93	0.90	0.71	0.78	0.84
Per page	8.04	6.66	6.15	5.05	5.66	5.36	6.87	5.49	5.83	6.91
Per member	6.53	5.93	5.18	4.33	5.52	5.05	5.31	4.26	4.63	4.94
Per member per 1,000 pages	10.41	8.49	7.13	6.34	7.53	6.67	8.61	6.87	7.35	8.43
Per member per 1,000 pages of text	15.01	11.63	10.61	8.55	10.21	8.78	12.01	9.66	10.57	12.62
NET COST:										
Total	$489.13	$539.21	$306.77†	618.37†	$276.54	$534.72	$609.81	$407.21†	$455.57†	$162.33†
Per copy	0.11	0.12	0.07†	0.14†	0.06	0.12	0.13	0.08†	0.09†	0.03†
Per page	0.78	0.77	0.46†	0.81†	0.38	0.71	0.99	0.66†	0.72†	0.28†
Per member	0.63	0.69	0.39†	0.78†	0.35	0.67	0.76	0.51†	0.57†	0.20†
Per member per 1,000 pages	1.01	0.98	0.58†	1.02†	0.47	0.88	1.24	0.82†	0.90†	0.34†
Per member per 1,000 pages of text	1.46	1.35	0.80†	1.37†	0.64	1.16	1.73	0.92†	1.29†	0.51†

*Including comprehensive index, 1882 to 1939, and 102 pages of standard specifications.
‡Including 45 pages of standard specifications.
**Including 28 pages of standard specifications.
†Profit.

Circulation. The present circulation of the JOURNAL is:

Members, all grades	826
Subscribers	146
Exchanges	23
Advertisers	47
Total	1,042

JOURNALS have been sent to all subscribers and to advertisers.

Respectfully submitted,

(*Signed*) GEORGE C. HOUSER, *Editor*

ANNUAL REPORT OF THE COMMITTEE ON LIBRARY

September 17, 1946

To the New England Water Works Association:

During the past year the library has been used to a limited extent only by the members of the Association.

A most interesting English treatise on "The Water Supply of Cities and Towns" by Humber, published in 1879, has been received from the Boston Society of Civil Engineers. This book contains numerous and excellent plates illustrating English practice in water works engineering some sixty years ago.

The Boston Society of Civil Engineers has also turned over to the library a number of early reports relating to New England water works which are of historical interest.

Again the Committee wishes to point out the availability of the Association's library for reference and study purposes by its members.

Respectfully submitted,

(*Signed*) E. SHERMAN CHASE, *Chairman*
FRANCIS H. KINGSBURY

ANNUAL REPORT OF COMMITTEE ON MEMBERSHIP—1946

To the New England Water Works Association:

Soon after the officers of the Association were elected for the current year, the President appointed your Committee on Membership with suggestions as to systematic canvass of individuals, municipalities and corporations which might be interested in appropriate membership in the New England Water Works Association. Generally following his suggestions, the Committee made a wide canvass of superintendents of water departments for individual membership, of the departments for corporate membership and of manufacturers for associate membership. The results of this canvass were gratifying, resulting in the following new members being elected:

Regular members	61
Corporate members	3
Associate members	3
Total	67

In addition, there are now on hand 9 applications for membership and 2 for associate membership which, if favorably acted upon by the Executive Committee at the Annual Convention, will bring a total result of the activity of your Membership Committee for the year to 78.

In its work the Committee solicited the help of various superintendents known to reside in areas where possible candidates might be found, and your Committee wishes to give full appreciation to the efforts of such individuals.

During the year Individual Membership losses were as follows:

Resigned	15
Died	11
Dropped by the Executive Committee	16
	42

Losses in Corporate Membership were as follows:

Dropped by the Executive Committee	1

Losses in Associate Membership were as follows:

Resigned	6
Making a total loss for the year	49
Net gain for the year	29

Respectfully submitted,

WARREN J. SCOTT
J. ELLIOTT HALE
LEONARD W. TRAGER
EDWARD L. TRACY
WALTER J. SHEA

(*Signed for the Committee*)

FRANCIS H. KINGSBURY
Chairman

ANNUAL REPORT OF THE FINANCE COMMITTEE

August 31, 1946

To the Executive Committee of the New England Water Works Association

GENTLEMEN:

Your Finance Committee herewith presents its report on the budget for the year 1945-1946 and its recommended budget for the year 1946-1947.

The Committee has examined figures obtained from the records of the Association during the past year and has consulted with the Treasurer with reference to probable revenue and expenditures during the coming year.

During the past year the following changes have taken place in the membership roster:

	Resigned	Deaths	Dropped	Additions	Gain	or Loss
Members	15	11	16	61	19	
Corporate	0	0	0	0		
Associate	9	0	0	3		6
Total	24	11	16	64	19	6

It will be noted from the above figures that there has been a gain of 19 members and a loss of 6 Associates, a net gain of 13. The growth in membership is about the same as has occurred for the past two years. Due to the increase in post-war activities, it is probable that there will be a somewhat larger growth during the coming year but the growth will probably not be large enough to be of significance in the budget. The revenue from dues for this year is now estimated at $400 above the figure set by the Finance Committee last year. While it is probable there may be some increase during the next fiscal year due to new members, the amount involved is probably not large enough to be considered in the budget.

During the current year increased costs have been experienced

in most of the items making up the budget. In view of this fact, a contingent fund of $1,000 was voted at the Bridgeport meeting. The actual costs have exceeded the original budget estimate by $938.36.

Analysis of the records of the closing year are shown in the tables below:

REVENUE FOR 1945-1946

	Budget	Actual	Difference
Initiation Fees	$ 150.00	$ 206.00	$ 56.00 balance
Dues	5,600.00	5,992.50	392.50 balance
Interest and Dividends	375.00	393.52	18.52 balance
Journal	4,000.00	4,215.41	215.41 balance
Miscellaneous	50.00	42.18	7.82 deficit
Total	$10,175.00	$10,849.61	$674.61

EXPENDITURES FOR 1945-1946

	Budget	Actual	Difference
General and Administrative	$4,600.00	$ 5,125.58	$525.58 deficit
Meetings and Committees	1,000.00	1,209.70	209.70 deficit
Publication of Journal	3,800.00	4,053.08	253.08 deficit
Miscellaneous	50.00	none	50.00 balance
Total	$9,450.00	$10,388.36	$938.36 deficit
Contingent Fund*	$1,000.00		

*This sum of $1,000, not in the original budget, was appropriated by vote of membership at the Bridgeport meeting.

It will be noted that the actual revenue has exceeded the budget estimate by $674.61 but that the actual expenditures have exceeded the budget by an even greater amount, $938.36. Your Finance Committee is cognizant of the current period of inflation and expects that costs will be even greater during the coming years. To offset some of this increase in costs, the Executive Committee is studying the matter of an increase in revenue from advertising. A tentative schedule of new rates is now being studied which, if put into effect, will result in an increased revenue of about $1,200 per year. The Finance Committee in making up the budget has assumed that this new schedule of rates for advertising will be put into effect immediately, in which case about one-half of the increase in revenue will be available for the next fiscal year. The recommended budget for the ensuing year is shown in the tables below:

BUDGET FOR 1946-1947, REVENUE

Initiation Fees	$ 150.00
Dues	6,000.00
Interest and Dividends	350.00
Journal	4,800.00
Miscellaneous and contingencies	125.00
Total	$11,425.00

BUDGET FOR 1946-1947, EXPENDITURES

General and Administrative	$ 6,000.00
Publication of Journal	4,500.00
Meetings and Committees	1,500.00
Contingent Fund	500.00
Total	$12,500.00

It will be noted from the above budget that the Finance Committee recommends expenditures the total of which will exceed the estimated revenue by more than $1,000. It is suggested that no effort be made to balance this budget during the next year or two and that the deficit be drawn from reserves which are more than ample. In the meantime, the trend in costs should be watched during the inflationary period with a view to stabilizing the budget at an appropriate time.

The reserve on hand at the close of this fiscal year amounts to $24,807.43. These funds are shown in the following table:

Checking Account and Cash	$ 4,627.22
Bonds	10,000.00
Savings Account	8,068.46
Serial Shares	2,111.75
	$24,807.43

The above reserve has been built up over a period of years in an amount which is large enough to warrant a formulation of policy regarding future financing. There is no apparent need for so large a reserve, inasmuch as the Association should operate, on the average, on a balanced budget. The devaluation of the dollar during the current inflationary period bids fair to be more or less permanent if the country is to reduce its national debt. In view of this trend the

Association will probably have to face the issue during the next few years of a further increase in revenue, probably from dues. In meeting this issue a study should be made of general policy concerning the reserve funds.

Respectfully submitted,

(*Signed*) THOMAS R. CAMP, *Chairman*
PHILIP J. HOLTON, JR.
GEORGE C. BEAN

ANNUAL REPORT OF THE COMMITTEE ON LEGISLATION

To the New England Water Works Association:

Your Committee on Legislation presents the following report for the year.

There were no regular sessions of the legislature in Maine, New Hampshire, Vermont or Connecticut and no water works legislation of interest was proposed in those States, nor in Rhode Island. It may be of interest to note that, although legislation was passed last year enabling Rhode Island towns to take over certain privately owned water systems, no towns have taken such action this year.

In Massachusetts, annual sessions were resumed and over two thousand petitions presented for action. An unusually small number affected water works systems but your committee examined about fifteen and found three which may be of interest.

House Bill No. 505, proposing to simplify the procedure for town wishing to adopt a town-manager form of administration, was referred to the Committee on Towns for a recess investigation. This bill seemed objectionable in that experienced heads of water departments might easily be replaced by town managers. The chairman of this committee spoke in opposition at the committee hearing.

While the enactment of House Bill No. 1586 is local to Cambridge in its direct application, its passage indicated the tendency to divert water-works income to the support of other municipal activities, rather than to reduce water rates when a surplus is built up beyond the expected requirements of the system.

House Bill No. 1849 provides for emergency water connections to towns from the Metropolitan Water District but also, and of more importance, establishes a rate of forty dollars per million gallons for water supplied by that District.

Respectfully submitted,

(*Signed*) ARTHUR C. KING, *Chairman*

SIDNEY S. ANTHONY	PHILIP J. HOLTON, JR.
WALTER C. CONROY	PERCY R. SANDERS
THEODORE L. BRISTOL	EDWARD L. TRACY

ANNUAL REPORT OF COMMITTEE ON COMMITTEES—1946

To the New England Water Works Association: This committee, appointed by the Executive Committee of the Association to promote coordination of committee activities in the Association and to promote the establishment of new technical committees where this seems advisable, submits a brief report. Our committee has followed its usual practice of communicating with the various committee chairmen to ascertain their ideas as to continuance of committees and their plans with regard to reports. We have also checked up during the year with other associations regarding joint committees. The Program Committee has been advised as to those committees desiring to submit reports at the annual meeting. Committee work has been greatly curtailed during the war years but there is expectation that increased activity by committees will soon be possible. Inactive committees should so far as possible be eliminated but certain committees dealing with preparation or approval of standards and specifications are subject to limitations or serve to represent the association in fields where changes may be proposed.

During the past year two new committees were appointed by the Executive Committee. One was a Committee on Technical Specifications from Joint Committees. A second was a Committee on Water Distribution Safety, a joint committee with A.W.W.A. Some changes were made, as usual, in committee membership.

The following committees will either submit progress reports or, in the opinion of this committee, should be continued:

Committee on Cathodic Protection of Steel Tanks and Standpipes.

Committee on Classification of Water Works Employees and Salaries.

Committee on Code for Pressure Piping. (Joint Committee with A.S.M.E.)

Committee on Coefficients for Friction in Pipe Lines.

Committee on Committees.

Committee to Report on Developments in our Knowledge of Corrosion and Its Mitigation.
Committee to Report on Developments in Water Quality Standards.
Committee on Finance.
Committee on Gate Valves. (Joint Committee with A.W.W.A.)
Committee on Hydrant Specifications. (Joint Committee with A.W.W.A.)
Committee to Investigate Grounding. (Cooperating with the American Research Committee on Grounding)
Committee on Laying Cast-Iron Pipe. (Joint Committee with A.W.W.A.)
Committee on Legislation.
Committee on Library.
Committee on Membership.
Committee on Meter Specifications. (Joint Committee with A.W.W.A.)
Committee on Rainfall and Yield of Drainage Areas.
Committee on Reciprocal Relations with the Institution of Water Engineers (England).
Committee on Reinforced Concrete Pressure Pipe. (Joint Committee with A.W.W.A.)
Committee on Sluice Gates. (Cooperating with Committee of A.W.W.A.)
Committee on Specifications for Cast-Iron Pipe and Special Castings. (Sectional Committee under A.S.A.)
Committee on Specifications on Steel Pipe. (Joint Committee with A.W.W.A.)
Committee on Standardization of Pipe Flanges and Fittings. (Sectional Committee under A.S.A.)
Committee on Steel Standpipes and Elevated Tanks. (Joint Committee with A.W.W.A.)
Committee on Survey of Ground Water Supplies in New England.
Committee on Survival and Retirement Experience with Water Works Facilities. (Joint Committee with A.W.W.A.)
Committee on Technical Program.
Committee on Technical Specifications from Joint Committees.

Committee on Threads for Underground Service Lines. (Joint Committee with A.W.W.A.)

Committee on Valve Box Frames and Covers. (Joint Committee with A.W.W.A.)

Committee on Water and Sewage Works Development. (Joint Committee with A.W.W.A.)

Committee on Water Distribution Safety. (Joint Committee with A.W.W.A.)

Committee on Water Quality Tolerances for Industrial Uses.

Discontinuance of Committees. The chairman of the Committee on Post-War Activities has recommended that this committee be discontinued, which would appear in order. The chairman of the Committee on Wartime Activities has reported to this committee that he understands his committee to be discharged.

New Committees. This committee recommends that a committee be designated to report to the Executive Committee on a program of public education in the water supply field, either through paid expert service or in some other way.

Conclusions and Recommendations. It is recommended that the standing committees listed above be re-appointed. It is also recommended that consideration be given to the appointment of a committee to study a possible program of public education in the water supply field. Very little general information gets out to the public on water supply progress and handling of water supply problems. Additional publicity for the association meetings might well be considered also by such a committee. It is hoped that some of the standing committees, some of which have been headed up by men only lately returned from the armed services, may be able to carry out further work during the next year.

Respectfully submitted,

(*Signed*) WARREN J. SCOTT, *Chairman*
THOMAS R. CAMP
HARRY U. FULLER
ARTHUR C. KING
ARTHUR L. SHAW

ANNUAL REPORT OF THE COMMITTEE ON RECIPROCAL RELATIONS WITH THE INSTITUTION OF WATER ENGINEERS

September 17, 1946

To the New England Water Works Association:

Last year your Committee reported that Mr. Karl R. Kennison had prepared and transmitted to the Institution of Water Engineers an exchange paper upon "Water Supply Developments in Boston, Massachusetts, and Recent Additions to the Works". This paper was presented at the Winter Meeting of the Institution by Mr. H. J. F. Gourley who had delivered a paper before our Association in 1936. The merit of Mr. Kennison's paper was such that he was awarded a premium by the Council of the Institution. Mr. Kennison is the second of our members to be so honored. In 1931 a paper by Mr. Caleb M. Saville of Hartford was similarly recognized.

A return paper, now due from the English society, is likely to be delayed as a result of the post-war problems with which English water engineers are faced.

Respectfully submitted,

(*Signed*) E. SHERMAN CHASE, *Chairman*
LELAND G. CARLTON
PERCY A. SHAW

PROGRESS REPORT OF THE COMMITTEE ON GATE VALVES

To the New England Water Works Association: The Committee on Gate Valves of the New England Water Works Association submits as a progress report for presentation to the Association at its Annual Meeting in September, 1946, the attached copy of a letter from F. A. Randlett, Chairman of the American Water Works Association Committee on Valve Specifications, addressed to Harry E. Jordan, Secretary of the A.W.W.A., dated May 10, 1946, and summarizing the activities of the Valve Committee during the year.

It is to be noted that a revised draft of the specifications is to be available during the coming year and that the scope of the specifications may be widened to include gate valves other than those ordinarily used for water works service.

Your Committee plans to mark time until this revised draft of the specifications is made available to them.

Respectfully submitted,

(*Signed*) LELAND G. CARLTON
WALTON H. SEARS
H. W. GRISWOLD, *Chairman*

May 10, 1946

MR. HARRY E. JORDAN, SECRETARY
American Water Works Association
500 Fifth Avenue
New York City 18.

Dear Mr. Jordan:

A meeting of the Valve Committee of the A.W.W.A. was held at St. Louis on May 7th. Messrs. Payne, Erickson, Lischer and O'Brien were present. Benedict and Luce absent.

The subject matter in regard to the questionnaire sent out to various areas in the country was revised together with data from Messrs. Griswold and Sears.

After a general discussion it was decided that the Chairman of this Committee, with the assistance of Mr. O'Brien, would take the present specifications, effective May 1, 1939, and rewrite certain paragraphs with the idea of eliminating ambiguities and confining descriptions to specific workmanship and materials as the minimum standard together with certain possible additions and certain paragraphs deleted referred to by sections and numbers.

Upon completion the draft will be sent to the members of the Committee for their remarks and criticisms with a view to recommending at the earliest possible meeting of the Committee the final draft of the specifications as a whole. An attempt will be made to include or suggest certain specification requirements for valves used on the discharge end of pumps and filtration plants as well as those used in distribution systems.

The present specifications dated May 1, 1939, touch only upon valves 3″ to 48″ in diameter for ordinary waterworks service under operating pressures not exceeding 150 pounds per square inch and, consequently, the Committee may decide to suggest a different specification not included in this proposed revision for valves that will be used in pumping and filtration plants.

Of the 223 questionnaires sent out, 82 replies were received. A very considerable number of the replies emphasized two criticisms of the present valve specifications; namely, protection against internal corrosion and breaking of valve stems.

The Committee decided not to consider rising-stem gate valves for distribution systems.

This constitutes a brief summary of the discussion that took place at the above-mentioned meeting.

Respectfully yours,

F. M. RANDLETT, *Chairman*
AWWA Committee on Valve
Specifications

PROGRESS REPORT OF THE HYDRANT SPECIFICATION COMMITTEE

To the Members of the New England Water Works Association:

At this time your Hydrant Specification Committee wishes to report progress on the revision of the present hydrant specifications.

We have been kept informed as to the activities of the A.W.W.A. Hydrant Specification Committee and, as soon as they make a report of their proposed revised specifications to this committee, we will take them up for consideration.

At the present moment Section 3.11 of the present specifications is up for clarification. It reads as follows:

> *3.11 Operating Mechanism:* The operating threads of the hydrant shall be designed so as to avoid the working of any iron or steel parts against other iron or steel. Either the operating stem or the operating nut shall be, or both may be, of non-corrodible metal. The operating stem and nuts shall have square, V, or Acme threads which shall be designed with a factor of safety of not less than 5 for all stresses that may occur when a wrench with a 15-in. arm is used on a hydrant subjected to water pressure of 150 psi.

From information that has been sent to us by the A.W.W.A. Hydrant Specification Committee, it seems to be the desire of the committee to set a certain figure, instead of saying "shall be designed with a factor of safety of not less than 5 for all stresses," etc.

It has been brought out by actual tests that a man can exert a pull or torque of 150 to 200 foot-pounds to the operating mechanism with a hydrant wrench with a 15-inch arm on a hydrant subjected to water pressure of 150 psi. without causing deformation.

If a man can exert that amount of pull or torque to the operating mechanism of a hydrant it seems fair and reasonable that there should be some degree of safety provided in the thickness, quality, and kind of material to withstand a greater stress—or yielding point.

If an ordinary man can exert a pull of 150 foot-pounds, then a 300-foot-pound requirement does not appear to be unreasonable.

There may be other factors which have not yet been called to our attention, that may clear this matter up to the mutual satisfaction of all concerned.

It is our aim to cooperate with the manufacturers, insurance companies, and with all of the water works operators, to bring about a simplification of the existing standards so that there will be only one standard. It seems to us that this is a most desirable aim which should be welcomed by the manufacturer and a protective measure to the users.

We would like to make a suggestion that the present committee be continued for another year.

(*Signed*) ROGER W. ESTY, *Chairman*
HAROLD W. GRISWOLD
HARRY U. FULLER

PROGRESS REPORT OF THE COMMITTEE ON LAYING CAST-IRON PIPE

To the New England Water Works Association: At the last annual meeting your Committee, appointed to cooperate with the American Water Works Association in revision of its Specifications for Laying Cast-Iron Pipe, reported that the specifications had been reviewed and suggested revisions submitted to the A.W.W.A. Committee for consideration.

The A.W.W.A. Committee still has the suggested revisions under review. Your Committee reports no further progress at this time but will continue to cooperate with the American Water Works Association and will report at an appropriate time.

Respectfully submitted,

(*Signed*) W. S. MARINER, *Chairman*

PROGRESS REPORT OF THE COMMITTEE ON SLUICE GATES

To the New England Water Works Association: Your Committee on Sluice Gates, cooperating with a similar Committee of the American Water Works Association, consisted of William R. Conard, Chairman, and the writer. Because of Mr. Conard's death in May, the writer is submitting the following progress report for the Committee.

The Specifications for Sluice Gates were approved as "Tentative" by the Board of Directors of the A.W.W.A. June 26, 1941, and have remained since that time in this status awaiting an acceptable specified procedure for shop testing. On April 12 last, Mr. Stephenson, Mr. Conard and myself met at Springfield, Massachusetts, and drafted a revision of *Section 22—Testing,* which was to have been submitted to the Water Works Practice Committee of the A.W.W.A. at its meeting during the May Convention at St. Louis. However, because of a misunderstanding as to the membership of the Committee, and because of Mr. Conard's death just prior to the St. Louis Convention, this revision was not submitted at St. Louis and the present specifications remain as tentative. As a matter of record, a copy of the proposed revision of *Section 22—Testing* is attached.

Respectfully submitted,

(*Signed*) H. W. GRISWOLD,
Member of the Sluice Gate Committee.

SPECIFICATIONS FOR SLUICE GATES

Suggested Revision of

Section 22—Testing

As Prepared by Messrs. Conard, Stephenson and Griswold

April 12, 1946

22.01—After completion, each Sluice Gate shall be assembled in the shop, together with its operating mechanism, and subjected to the following tests, which shall as nearly as possible simulate operating conditions:

1. To demonstrate that the operating mechanism operates properly.

2. To demonstrate the water-tightness of the gate when closed and under the head for which it was designed (75 feet for gates up to and including 36″ x 36″, and 50 feet head for larger gates up to and including 96″ x 96″), with the pressure and other tests being applied in a direction of seating the gate against the frame seat.

3. A—To demonstrate the ability:
   To operate from closed to open position, not under pressure.
   B—To demonstrate the ability:
   To open and close again with no greater travel than the releasing and engaging again of the wedging mechanism, under twice the pressure head for which the sluice gate is designed.

22.02—The test for leakage shall be carried out as follows:

1. While the gate is under test for leakage it shall be subject to careful scrutiny and the leakage measured. The allowable leakage shall be in the form of drops and in no place so concentrated as to form a stream, and the total amount shall not exceed one (1) pint per hour per linear foot of seats as measured on the center line of gate seat.

2. Suitable measuring and timing devices, for catching, measuring and timing the amount of leakage under the specified head, shall be used, which devices shall be shown to be accurate and shall be provided for testing each sluice gate.

22.03—Sluice Gates of special design, for heads other than indicated in *22.01*, condition *2*, or for pressures tending to unseat the gate, shall be tested in the same manner, but as agreed upon in writing between the purchaser and producer.

PROGRESS REPORT OF COMMITTEE ON SPECIFICATIONS FOR CAST-IRON PIPE AND SPECIAL CASTINGS

September 1, 1946

To the New England Water Works Association:

The preparation of the report of your representatives in A.S.A. Committee A21, on Specifications for Cast-Iron Pipe and Special Castings, falls upon the writer because of the death of William R. Conard who, as senior member of your representation, has, in the past, attended to this duty.

The work of the committee has been somewhat curtailed owing to war-time activities, but progress has been made in certain directions as briefly outlined in the following paragraphs.

Pipe Other Than Pit-Cast. It has been found necessary to consider separately pipe cast centrifugally in water-cooled molds and in sand-lined molds. Attention has thus far been directed principally to the specifications for the deLavaud type. It is now the intent that consideration of both deLavaud and sand-cast types will be pressed at coming sessions.

Tar Dip Specifications. These specifications, which have been tentatively issued, are still held up for reconsideration before submission as standard because of certain criticisms.

Short Body Fittings. Specifications were completed and approved by Committee A21 but thereafter the producers withdrew their approval and requested reconsideration of certain pressure ratings. This matter is on the agenda for the next meeting.

Long Standard Fittings. Full-scale tests of large fittings were interrupted by the war, but the producers will continue them as soon as conditions permit, in order to determine proper dimensions. Tests of large fittings are very expensive, and there have been suggestions for testing small-scale models, perhaps of materials different from cast-iron.

Cement Lining. The producers have proposed changes in the

specifications which have been in force since 1939, in order to shorten the curing period by the use of bituminous "curing aids" in place of long-time curing by sprinkling with water. Consideration is also being given to the addition of hardness and solubility requirements. A revision of the specification will probably issue before long.

General. While progress of Committee A21 has been slow, it should be recalled that this committee was established as a research committee with the intention of issuing specifications only as research permitted conclusions to be drawn.

The research has been conducted largely through the generosity of the producers with funds and in their laboratories. These laboratories have increased in number, personnel and scope during the war, and it is hoped that this may facilitate more rapid future progress.

Yours respectfully,

(*Signed*) ARTHUR L. SHAW

PROGRESS REPORT OF COMMITTEE ON TECHNICAL SPECIFICATIONS FROM JOINT COMMITTEES

To the New England Water Works Association: Your Committee on Technical Specifications from Joint Committees made its first report on January 19, 1944, to the Executive Committee. Since that time, the work of the twelve joint committees upon which N.E.W.W.A. has representation has been limited, owing to war-time conditions, and there has been but little active progresss.

In the meantime, there has been established in the Association office a card file showing the status of specifications issued or in progress under the several committees. This file will be kept up to date to show whether, and under what circumstances, specifications have been issued by committees, published in the JOURNAL, and acted upon by the Association.

It is recommended that the Editor consult this file with a view to publication from time to time, as space permits, of specifications not previously printed. This will serve the dual purpose of providing the membership with a permanent record of the documents in question and of informing the members in anticipation of appropriate votes looking toward official adoption by the Association.

Yours respectfully,

(*Signed*) KARL R. KENNISON
ARTHUR L. SHAW, *Chairman*

Committees of the New England Water Works Association 1946 - 1947

Committee on Technical Program: Stanley M. Dore, *Chairman,* George G. Bogren, William B. Duffy, Gordon M. Fair, George C. Houser, Paul F. Howard, Truman H. Safford and Marshall S. Wellington.

Committee on Northern New England Meeting: Sidney S. Anthony.

Committee on Southern New England Meeting: Philip J. Holton, Jr.

Committee on Finance: Thomas R. Camp, *Chairman,* Charles G. Richardson and James A. Sweeney.

Committee on Membership: Francis H. Kingsbury, *Chairman,* Howard H. Potter, Warren J. Scott, Leonard W. Trager, Edward L. Tracy and Walter J. Shea.

Committee on Library: Karl R. Kennison, *Chairman,* and Harry L. Kinsel.

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Committee on Legislation: Arthur C. King, *Chairman,* Sidney S. Anthony, Theodore L. Bristol, Walter C. Conroy, Philip J. Holton, Jr., Percy S. Sanders and Edward L. Tracy.

Committee on Reciprocal Relations with the Institution of Water Engineers (England): E. Sherman Chase, *Chairman,* Leland G. Carlton and Percy A. Shaw.

Committee on Classification of Water Works Employees and Salaries: Walter B. Bushway, *Chairman,* Walter C. Conroy, Roger G. Oakman, Albert E. Casey and Allen M. Symonds.

Committee on Survey of Ground Water Supplies in New England: Leslie K. Sherman, *Chairman,* Joseph C. Knox, Howard H. Potter, Walter J. Shea, Edward L. Tracy, Leonard W. Trager and M. L. Brashears, Jr.

Committee on Rainfall and Yield of Drainage Areas: Arthur D. Weston, *Chairman,* Harold K. Barrows, Allan T. Gifford, Francis H. Kingsbury, Harvey B. Kinnison, Peter C. Karalekas, Arthur T. Safford, Caleb M. Saville, Ralph M. Soule, Miner R. Stackpole and James L. Tighe.

Committee on Distribution System Safety: William E. Stanley, *Chairman,* Donald C. Calderwood and Frank A. Marston.

Committee on Survival and Retirement Experience with Water Works Facilities (Joint with American Water Works Association): Reeves J. Newsom, *Chairman,* Harry U. Fuller and Thomas H. Wiggin.

Committee on Cathodic Protection of Steel Tanks and Standpipes: Donald C. Calderwood, *Chairman,* Richard H. Ellis, Harry U. Fuller, Madison H. Goff, William P. Melley, Sidney S. Anthony and Howard E. Bailey.

Committee on Coefficients for Friction in Pipe Lines: Elson T. Killam, *Chairman,* Frank A. Barbour, William W. Brush and E. Shaw Cole.

Committee to Investigate Grounding (Cooperating with the American Research Committee on Grounding): George A. Sampson, *Chairman,* Warren A. Gentner, Arthur V. Harrington and Edward E. Minor.

Committee to Report on Developments in Water Quality Standards: Arthur D. Weston, *Chairman,* Almon L. Fales and Melville C. Whipple.

Committee on Water Quality Tolerances for Industrial Uses: Edward W. Moore, *Chairman,* Stuart E. Coburn, Louis A. Olney, Hervey J. Skinner and George A. Sampson.

Committee to Report on Developments in our Knowledge of Corrosion and its Mitigation: Edward W. Moore, *Chairman,* Lazarus Rubin and Walton H. Sears.

Committee on Specifications for Cast-Iron Pipe and Special Castings (Sectional Committee under American Standards Association): Elson T. Killam and Arthur L. Shaw.

Committee on Reinforced Concrete Pressure Pipe (Joint with American Water Works Association): Stanley M. Dore and George A. Sampson.

Committee on Code for Pressure Piping (Joint with American Society of Mechanical Engineers): Thomas F. Wolfe.

Committee on Laying Cast-Iron Pipe (Joint with American Water Works Association): W. S. Mariner, *Chairman,* and George W. Coffin.

Committee on Specifications for Steel Pipe (Joint with American Water Works Association): Frank A. Barbour.

Committee on Standardization of Pipe Flanges and Fittings (Sectional Committee under American Standards Association): Elson T. Killam, *Chairman,* and Frank A. Barbour.

Committee on Threads for Underground Service Lines (Joint with American Water Works Association): William W. Brush, *Chairman,* and Donald C. Calderwood.

Committee on Steel Standpipes and Elevated Tanks (Joint with American Water Works Association): George A. Sampson, *Chairman,* Howard E. Bailey, Harry U. Fuller and Henry E. Halpin.

Committee on Valve Box Frames and Covers (Joint with American Water Works Association): Sidney S. Anthony, *Chairman,* and Scott Keith.

Committee on Meter Specifications (Joint with American Water Works Association): Richard H. Ellis, *Chairman,* D. H. Hall and Warren A. Gentner.

Committee on Hydrant Specifications (Joint with American Water Works Association): Roger W. Esty, Harry U. Fuller and Harold W. Griswold.

Committee on Gate Valves (Joint with American Water Works Association): Harold W. Griswold, *Chairman,* Leland G. Carlton and Walton H. Sears.

Committee on Sluice Gates (Cooperating with Committee of American Water Works Association): Elson T. Killam, *Chairman,* and Harold W. Griswold.

Committee on Water and Sewage Works Development (Joint with American Water Works Association): E. Sherman Chase, *Chairman,* and Roger W. Esty.

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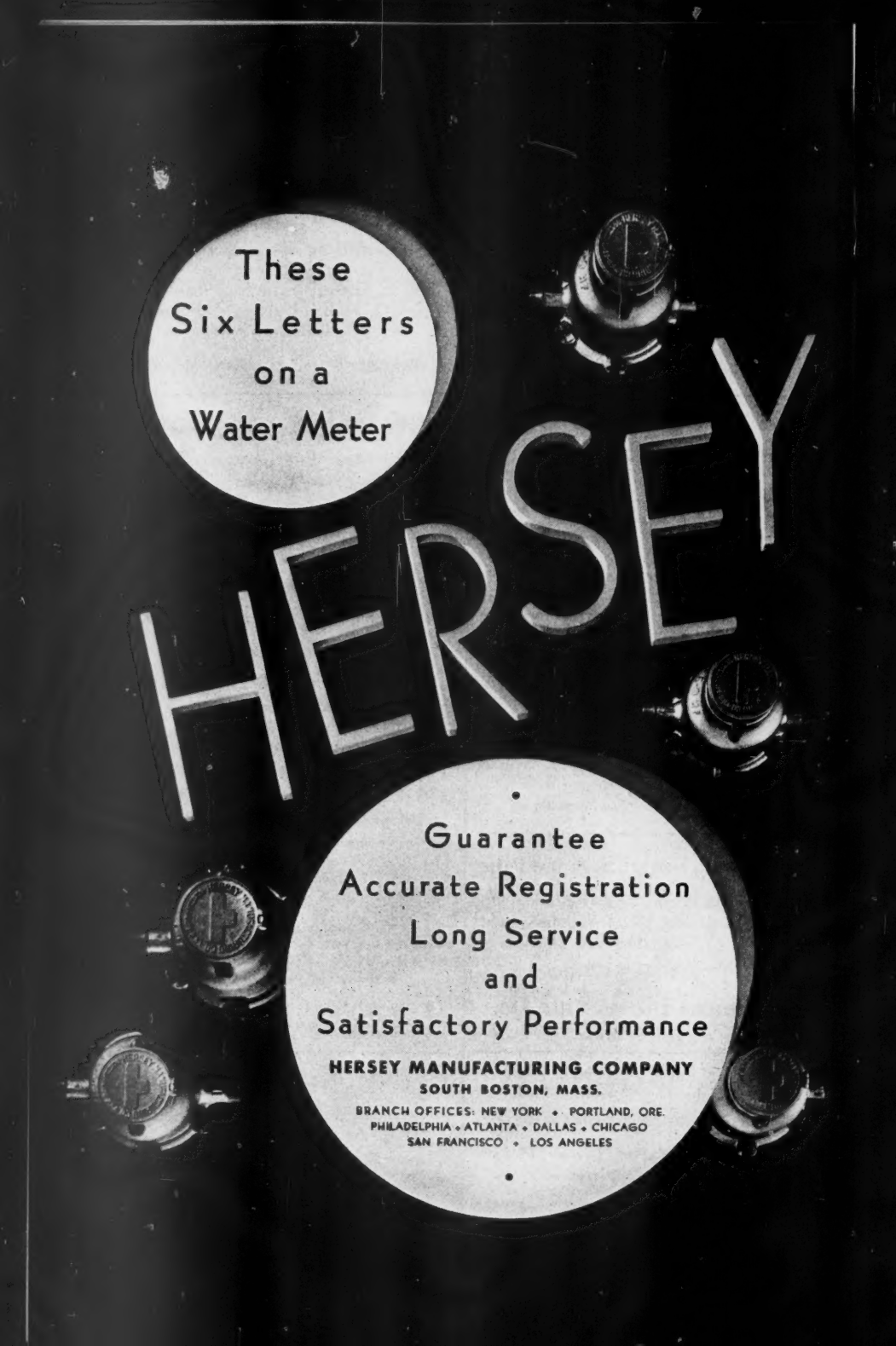
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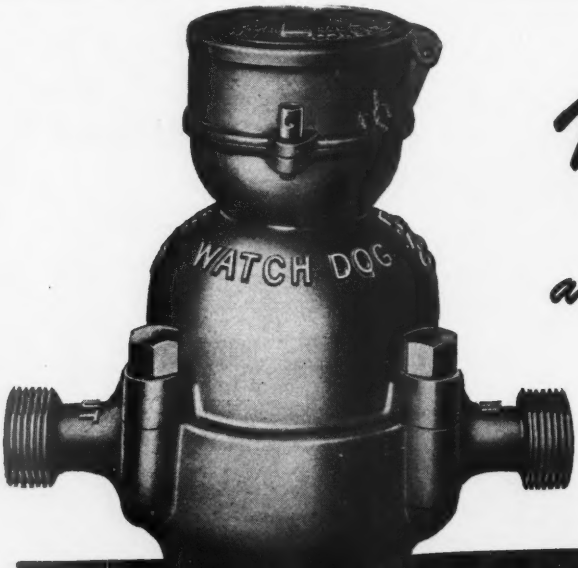

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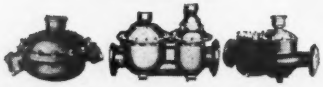

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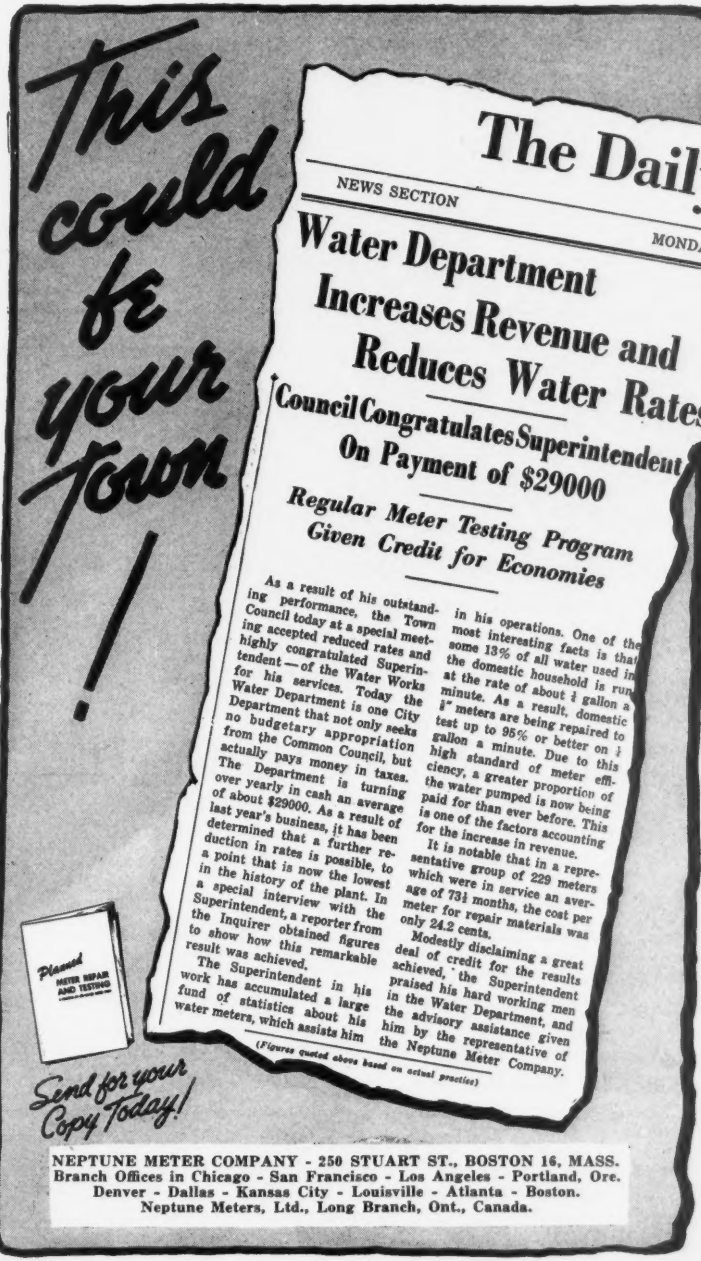
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The Daily
NEWS SECTION
MONDAY,
Water Department Increases Revenue and Reduces Water Rates
Council Congratulates Superintendent On Payment of $29000
Regular Meter Testing Program Given Credit for Economies
As a result of his outstanding performance, the Town Council today at a special meeting accepted reduced rates and highly congratulated Superintendent — of the Water Works for his services. Today the Water Department is one City Department that not only seeks no budgetary appropriation from the Common Council, but actually pays money in taxes. The Department is turning over yearly in cash an average of about $29000. As a result of last year's business, it has been determined that a further reduction in rates is possible, to a point that is now the lowest in the history of the plant. In a special interview with the Superintendent, a reporter from the Inquirer obtained figures to show how this remarkable result was achieved.
The Superintendent in his work has accumulated a large fund of statistics about his water meters, which assists him in his operations. One of the most interesting facts is that some 13% of all water used in the domestic household is run at the rate of about ¾ gallon a minute. As a result, domestic ¾" meters are being repaired to test up to 95% or better on ¾ gallon a minute. Due to this high standard of meter efficiency, a greater proportion of the water pumped is now being paid for than ever before. This is one of the factors accounting for the increase in revenue.
It is notable that in a representative group of 229 meters which were in service an average of 73¼ months, the cost per meter for repair materials was only 24.2 cents.
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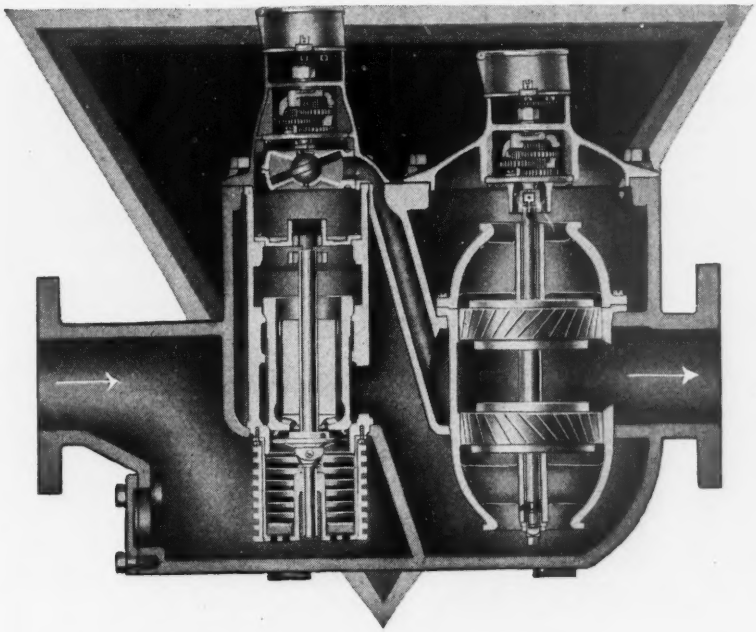

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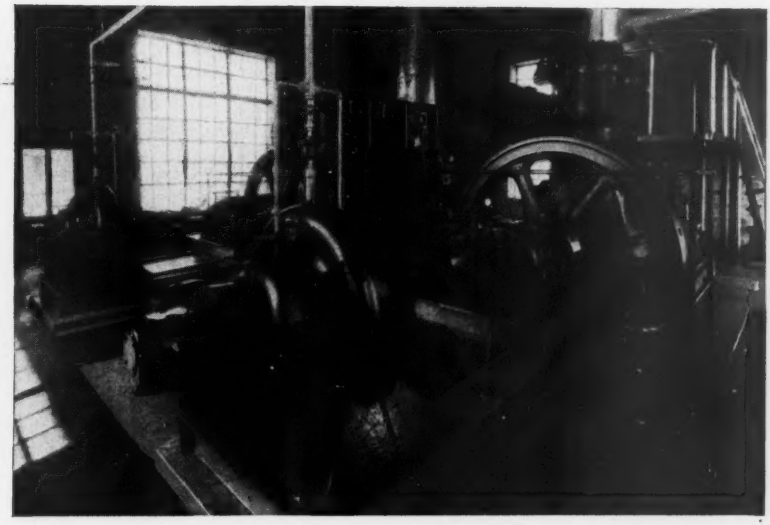

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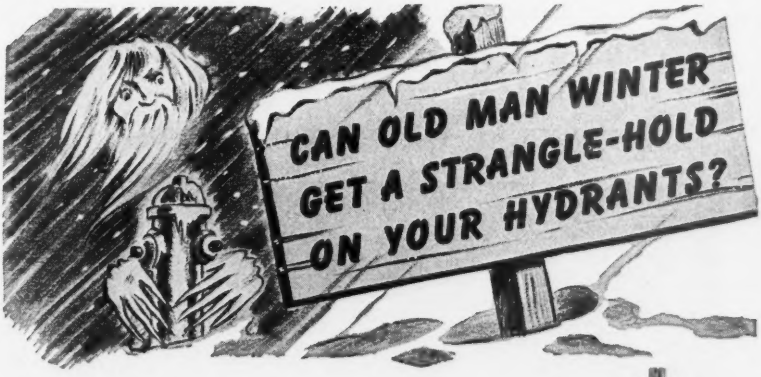

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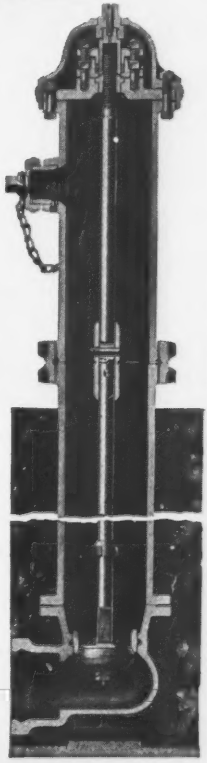

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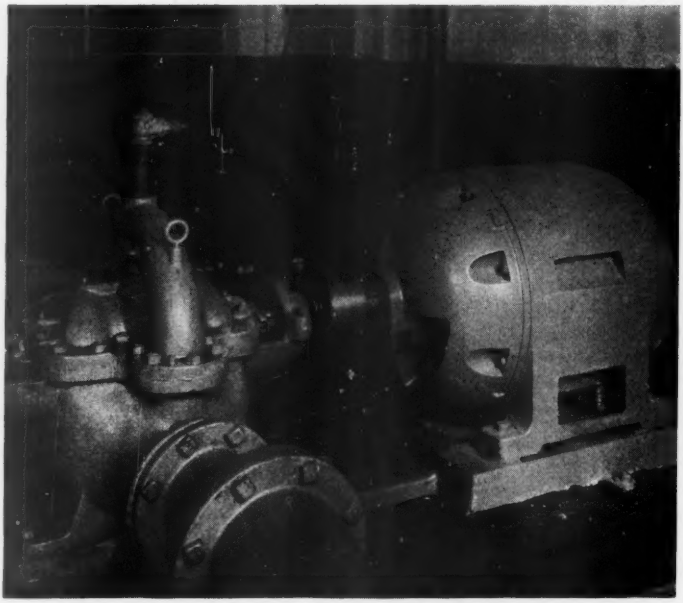

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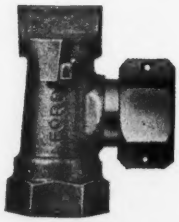
Ringstyle



The Ford RINGSTYLE Valve is an inverted key angle valve with meter coupling nut attached. For pit settings where meter is set on risers it makes a most convenient and satisfactory curb valve. Hundreds of thousands in service. Write for catalog and further information.

FORD METER BOX CO.,
WABASH, IND.

Important Savings

to make when laying Bell & Spigot Lines

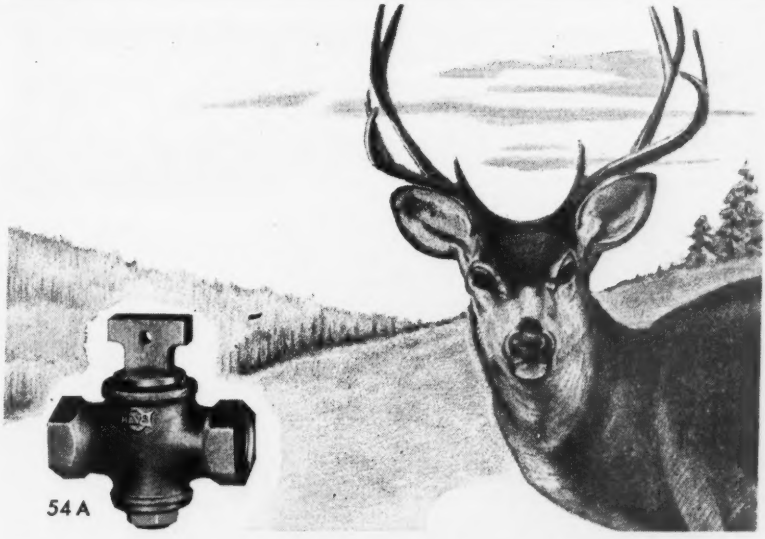
- REPEATED HYPOCHLORITE FLUSHINGS
- TIME CONSUMED IN RE-STERILIZATION. Put lines in service at once.
- UNWARRANTED WASTE OF WATER
- EXTRA TIME IN MAKING WET JOINTS

USE A HYDE-RO RING

IN EACH JOINT

This simple rubber device prevents recontamination, holds back water from leaky valves, gives dry joints, saves its cost over and over. Sizes 4" to 12". Works with *Tegul*-MINERALEAD, Portland Cement and lead. • For complete information, write

THE ATLAS MINERAL PRODUCTS COMPANY OF PENNA
Mertztown Pennsylvania



10 OUTSTANDING POINTS

AS the value of the hunter's prize is measured by the number of points carried by his prey, so are Hays Fittings valued, not for one, but for the many points in which they excel.

(1) All Hays Water Works Stops are made of a single, uniform, high quality brass, 85-5-5-5 mix.

(2) Hays Fittings are made in a large and modern plant, equipped with the most up-to-date machinery, for the efficient handling of orders large or small, for regular or special items.

(3) Standard threading permits use in any standard threading machine.

(4) Every Hays Fitting is hydrostatically tested at 200 lbs. or more pressure.

(5) Hays plugs are individually ground in, to assure a perfect fit.

(6) Hays Stops are specially lubricated for lasting service.

(7) Hays Stops are designed to allow ample water-way.

(8) Hays Fittings are made by workers steeped in the tradition of the best American craftsmanship, many of them the sons and grandsons of past and present Hays employees.

(9) Hays offers a complete line, economically adaptable to your present system.

(10) Back of every order you place is the confidence built by over three quarters of a century of fair and generous dealing.

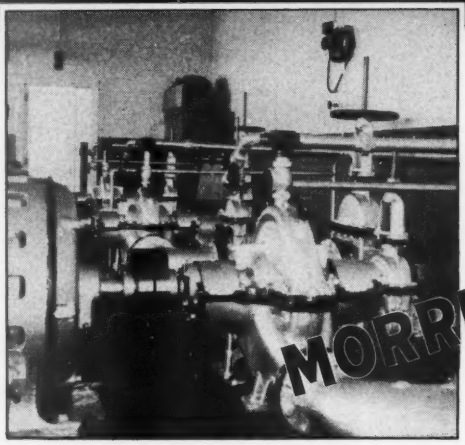
HAYS

COPPER · BRASS · LEAD · IRON

WATER WORKS PRODUCTS

HAYS MANUFACTURING CO., ERIE, PA.

In the modernized water supply system at New Bern



TWO reasons made it necessary for New Bern, N. C., to practically rebuild its water supply system—(1) a population which had doubled in a few short years, and (2) contamination by salt intrusion.

In the modernized New Bern Plant, one Morris 700 GPM, and two Morris 1400 GPM pumps—delivering water from storage tanks to the city's distribution system—have conclusively demonstrated their merits.

The 700 GPM pump is a 4″ unit with 5″ suction opening, and operates against a head of 143 feet. It is directly connected to a 40 HP, 1760 RPM motor. The 1400 GPM pumps are capable of pumping against a head of 165 feet, and are connected to 75 HP, 1760 RPM motors. These two units have 6″ discharge openings and 8″ suction openings. All pumps in this station are Morris standard, horizontally split design, bronze fitted, and the arrangement of the piping system is such that the two 1400 GPM pumps can at times be operated in parallel.

• *Municipalities all over the country have learned to specify MORRIS pumps, because of their efficiency, economy, long life, and consistent output. Feel free to consult our engineers about your particular needs. For there is a MORRIS pump for every job, and more than three-quarters of a century experience behind every MORRIS installation.*

MORRIS *Centrifugal Pumps*

MORRIS MACHINE WORKS, Baldwinsville, N. Y.
Offices in Principal Cities

EDDY

Valves and Hydrants

Distinctive Features of the EDDY Valves

ONLY three parts are moved by the Stem—the ball and the two gates. Each gate is hung from one of the trunnions on the ball. A convex surface at the base of each trunnion fits a concave surface on the back of the gate. This allows the gates to adjust themselves properly to their seats. . . . The gates, being free to revolve on the trunnions, do not always seat in the same position. Gates are center bearing and adjustable. They are forced to their seats with equal pressure at all points. There are two hooks on the ball on sizes 4-inch and larger, which loosely engage with the gates.

Distinctive Features of Our New Swivel Top Hydrants

THIS new hydrant has all the advantages of the popular EDDY fire hydrant, plus several additional features. . . . Nozzles are in a short flanged section of the standpipe, which may be unbolted and turned to different positions. . . . Should the standpipe be broken, only the casting below the swivel head need be replaced. . . . To raise the hydrant to conform to a new grading, simply insert a flanged extension piece below the swivelhead. No digging. To add a steamer nozzle at any time, it is only necessary to replace the swivel head with one having a steamer nozzle.

Besides valves and hydrants to meet the most exacting demands of waterworks service, the complete EDDY Line includes: valves for sewage disposal works; valves for steam, gas and oil; check valves, foot valves, plug valves, shear gates, indicator posts, etc. EDDY valves are made in three classes: Iron Body Bronze Mounted, All Bronze, and All Iron Valves.

Eddy Valve Co.

WATERFORD **NEW YORK**

SEASONAL TREATMENT shows how to bring gas-formers down

At this 4mgd municipal plant, Break-Point Chlorination was initially adopted to solve an unusually severe summer taste and odor problem. The extra margin of safety achieved was considered secondary, and during the winter Break-Point Chlorination was discontinued.

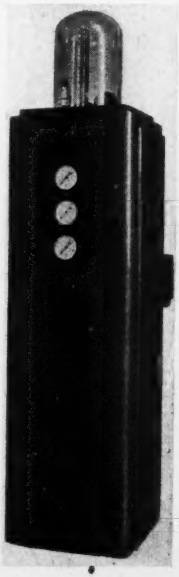
The peaks and valleys of the chart show the result – convincing proof of the effectiveness of Break-Point Chlorination in reducing *all* gas-formers.

Break-Point Chlorination--being adopted by more and more plants – substantially obviates the need for distinguishing between "confirming" and "non-confirming" organisms.

Your Wallace & Tiernan representative is ready to tell you how *free available chlorine residuals* maintained by Break-Point Chlorination can give your community a more palatable and safer water. Call him today.

BACTERIOLOGICAL DATA

	NORMAL CHLOR.	B-P CHLOR.	CHANGE
I.N (Indicated Number) Gas-Forming Organisms per 100 ml			
Filter Effluent	4.60	0.65	–85.9%
Clear Well	4.60	0.47	–89.7%
Plant Tap	4.90	0.50	–89.7%
City Tap	4.40	0.47	–89.3%



"The Only Safe Water is a Sterilized Water"

WALLACE & TIERNAN COMPANY, INC.

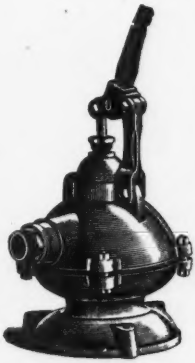
MANUFACTURERS OF CHLORINE AND AMMONIA CONTROL APPARATUS

NEWARK 1, NEW JERSEY • . REPRESENTED IN PRINCIPAL CITIES

SA-195

EDSON

PUMPS and ACCESSORIES



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Truck or Trailer Mounted
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Red Seal Diaphragms
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Warren Foundry & Pipe Corp.

ALSO

Warren Pipe Co. of Mass., Inc.

SALES OFFICES

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75 FEDERAL STREET, BOSTON, MASS.

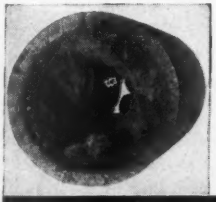
Manufacturers of

CAST IRON PIPE

Flanged Pipe ***Flexible Joint Pipe***
Bell and Spigot Pipe
Special Castings ***Short Body B. & S. Specials***
Warren (WF) Spun Centrifugally Cast Iron Pipe

WORKS: PHILLIPSBURG, N. J. and EVERETT, MASS.

Large Stock Enables Us to Make Prompt Shipments

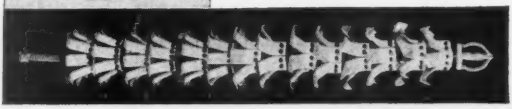


Get Full Service From Old Mains

The most practical way to meet today's overload demand is to clean clogged water mains. FLEXIBLE Underground Pipe Cleaning Co., specializes in such jobs— any size—2″ to 72″.

RAY BAHR

41 GREENWAY, HAMDEN, CONNECTICUT



New England Representative

Pipe Founders Sales Corporation

CAST IRON PIPE AND FITTINGS

FOR

Water, Steam, Gas and Culverts

Special Flanged and Bell and Spigot Castings

Lyncast Iron Chemical Castings

Office: 6 Beacon Street, Boston **Warehouse and Yard: East Cambridge, Mass.**

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Affiliated with Edward F. Hughes Company (Est. 1910)

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1879—ROSS— 1879

AUTOMATIC VALVES

Controls elevation of water in tanks, basins and reservoirs

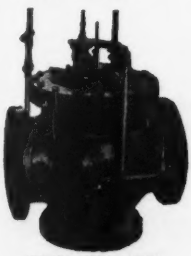
ALTITUDE VALVE

1. Single Acting
2. Double Acting

Maintains desired discharge pressure regardless of change in rate of flow

REDUCING VALVE

Regulates pressures in gravity and pump systems; between reservoirs and zones of different pressures, etc.



Maintains levels in tank, reservoir or basin

1. As direct acting

2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

FLOAT VALVE

A self contained unit, with three or more automatic controls

COMBINATION VALVE

Combination automatic control both directions through the valve.

Maintains safe operating pressures for conduits, distribution and pump discharge

SURGE-RELIEF VALVE

Electric remote control—solenoid or motor can be furnished

REMOTE CONTROL VALVE

Adapted for use as primary or secondary control on any of the hydraulically controlled or operated valves.

ROSS VALVE MFG. CO., INC. Box 592 TROY, N. Y.

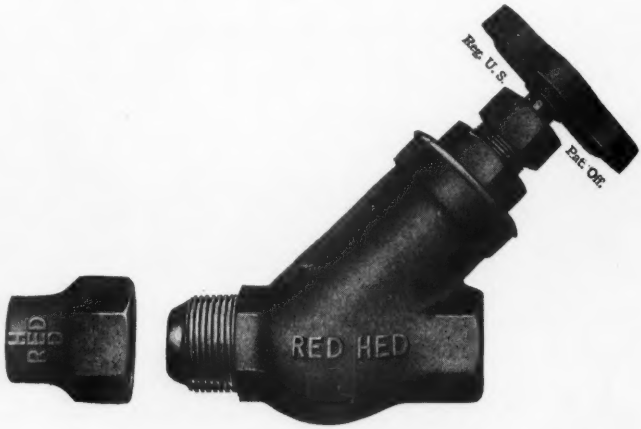


FIG. 460

RED HED Y Valves are made for use with wrought iron, brass or copper service tube. The full size water way, unobstructed permits of a free flow of water from the service pipe. The stuffing boxes in RED HED Y Valves may be repacked without shutting off the water. RED HED Y Valves are made with male or female threads as desired.

RED HED MFG. CO.

Manufacturers of

RED HED Brass Goods for Water Works

368 Congress Street **Boston, Mass.**

COMPLETE AUTOMATIC DRAINAGE

In an emergency, an unexpectedly frozen hydrant might easily spell disaster. In Ludlow Hydrants, nothing is left to chance. A brass drip valve, located at the lowest point in the barrel, opens automatically as the hydrant is shut off, insuring *complete and positive drainage at all times.*

More than a million Ludlow Hydrants are serving in thousands of cities and towns, both at home and abroad. Consider *your* community's needs, then write us for information.

The Ludlow Valve Mfg. Co., Inc., Troy, N. Y.

The drip valve opens as the gate reaches the closed position, assuring complete drainage below the gate at the lowest point in the barrel.

H-6

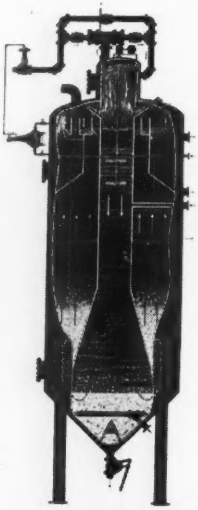
LUDLOW HYDRANTS

SUPERIOR FEATURES SINCE 1866

MUNICIPALITIES

In Every Direction

USE GRAVER WATER CONDITIONING SYSTEMS



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Process Equipment Division of
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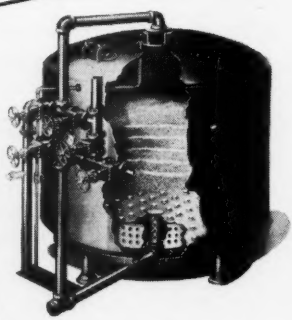
Graver Reactivator



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GRAVER

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IN NEW ENGLAND
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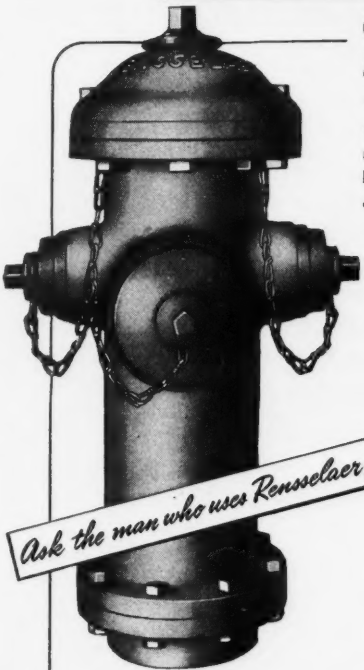
RENSSELAER
FIELD SERVICE



Our Representatives are Anxious to Serve You!

These factory-trained men are at your service when and where you need them, on short notice. Warehouse stocks normally maintained at points throughout the U. S.

Defender

FIRE HYDRANT

Backed by years of faithful service, these hydrants have proved their superiority in hundreds of installations.

This superiority is based on constant research and application of engineering knowledge to actual field problems. The outstanding features of Rensselaer Defender Fire Hydrants are described in our bulletin.

Write for Bulletin W

Please be patient. The wide acceptance of our products has caused some delays in deliveries.

PROMPT ATTENTION by the Rensselaer factory is assured whether you write, wire or phone a large order or a simple inquiry.

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Ross Valve Mfg. Co. xxiii

WATER WASTE DETECTION.
Pitometer Co. iii

WELL CONNECTIONS.
Red Hed Mfg. Co. xxiv

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You don't have to handle a rugged product, such as cast iron pipe, with kid gloves. However, use reasonable care in unloading, distributing and lowering it into the trench, and you give cast iron pipe a good start on the century or more of useful life cast into it at the foundry. A level trench bottom, without humps or hollows, and a tamped backfill (in all but sandy soils) are also important. Under normal conditions, cast iron pipe, so laid, need never see daylight again for centuries. But if population shifts require re-routing, or replacing with larger pipe, you can take up the original line, sell it or re-use it elsewhere. Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 S. Michigan Ave., Chicago 3.

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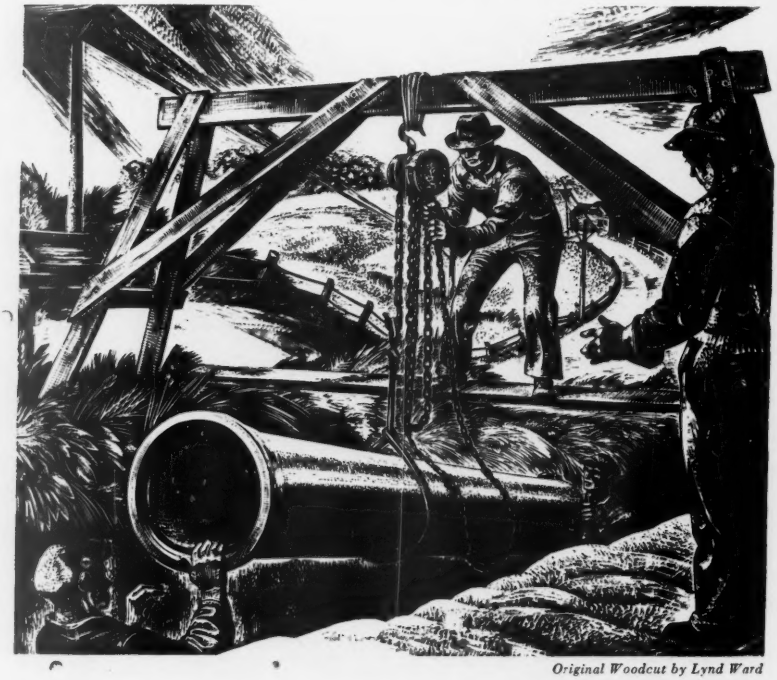

Original Woodcut by Lynd Ward

Lower away to a trench floor that's smooth and even —calk the joint thoroughly from top to bottom— tamp the backfill until well above the center of the pipe—and if it's U. S. Cast Iron pipe you're laying, you know that the line will cost little or nothing to maintain throughout a century or more of useful life. Good laying practice is co-operation by the construction crew with the pipe maker for the benefit of the taxpayer.

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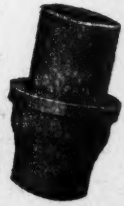
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